FIG. 1.—ELECTRICALLY-DRIVEN COAL GRAB INSTALLED NEAR THE HARBOR OF THE TEGEL GAS WORKS OF THE CITY OF BERLIN.
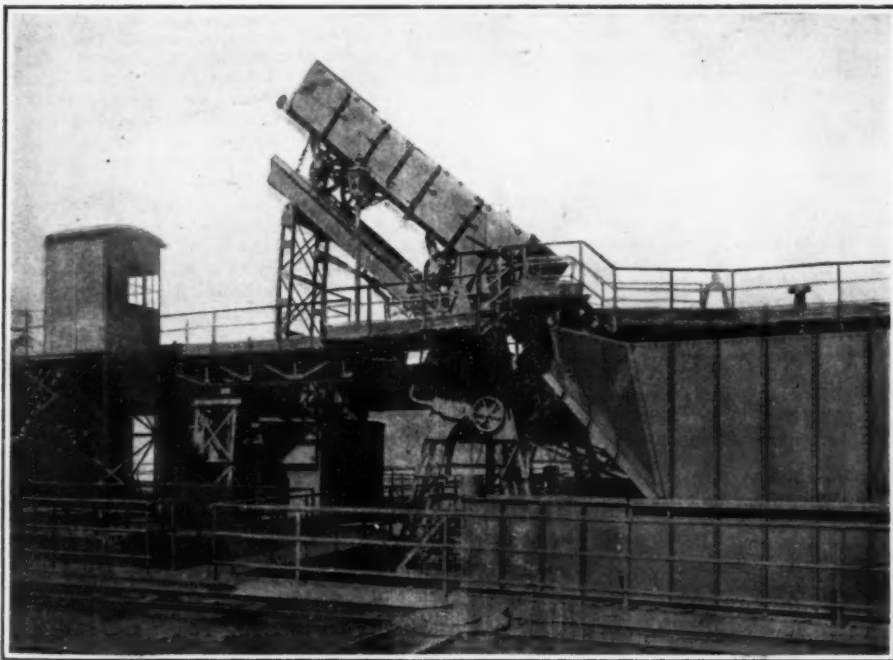

FIG. 2.—RAILWAY WAGON TILTING PLANT FOR UNLOADING COAL SUPPLY AT DANZIGER STREET GAS WORKS, BERLIN.
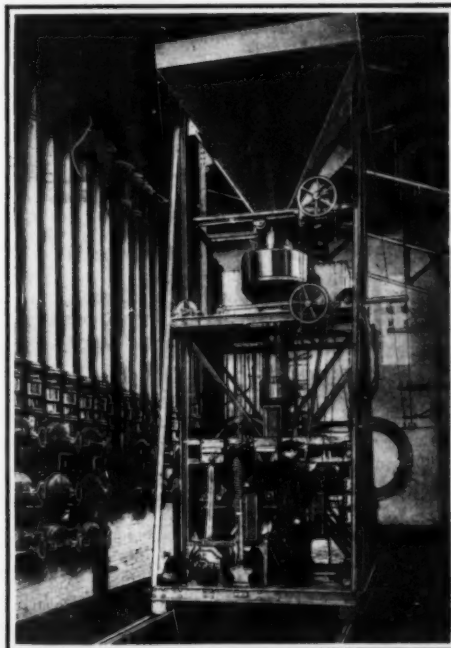

FIG. 6.—CHARGING AND DISCHARGING MACHINES USED IN CONNECTION WITH HORIZONTAL RETORTS.

ELECTRICITY IN GAS WORKS.—[SEE PAGE 424.]

RADIOACTIVITY.*

A BRIEF RESUMÉ OF OUR PRESENT KNOWLEDGE.

BY MADAME P. CURIE.

THE discovery of radioactivity is comparatively recent, going back only to 1896, the year in which the radiant properties of uranium were proved by Henri Becquerel.

The development of the science since has been extremely rapid, and among the numerous results obtained are some whose general scope is so widely extended that radioactivity constitutes to-day an independent and important branch of the physico-chemical sciences, occupying a precisely defined field of its own.

In the study of radioactivity the knowledge of the chemist and that of the physicist find applications of equal importance.

If the methods of analytic chemistry are constantly employed for the extraction of radioactive substances from their mineral compounds, various methods of physical measurement, and in particular, of electrometry, are of current usage for the study of these substances.

It is particularly interesting to remark the close connection which exists between the rapid development of radioactivity and the results obtained in a series of theoretical and experimental researches upon the nature of electromagnetic phenomena, and upon the passage of the electric current through gases.

These researches, which have established with great precision the conception of the corpuscular structure of electricity, comprise the study of the cathodic and positive rays, the discovery and study of Röntgen rays, and the study of gaseous ions. They have led to the idea of the existence of particles which carry positive or negative charges, and which may have dimensions comparable to atomic dimensions, or possibly dimensions considerably smaller.

The theory of ionization, which has been established to explain the characteristics of electric conductivity in gases, has been recognized as likely to furnish an interpretation of the conductivity acquired by a gas submitted to the action of a radioactive body; this theory has been applied to the study of radiations emitted by radioactive substances, and constitutes from this point of view a very valuable instrument of research.

Moreover, the rays of radioactive bodies present analogies of nature to cathodic, positive, and Röntgen rays, and can often be studied by analogous methods.

It may be said that the discovery of radioactivity occurred at a time when the ground was admirably prepared.

Closely allied to physics and chemistry, and borrowing the methods of work of these two sciences, radioactivity bring to them in exchange, elements of renewal.

To chemistry it gives a new method for the discovery, the separation, and the study of the elements, as well as the knowledge of a certain number of new elements of very curious properties—first of all, radium; and finally, the idea—of capital importance—of the possibility of atomic transformations under conditions subject to the control of experience.

To physics, and above all, to modern theories of corpuscles, it brings a world of new phenomena whose study is a source of progress for these theories. One might cite, for example, the emission of particles carrying electric charges and having a considerable rapidity, whose motion does not obey the ordinary laws of mechanics, and to which one may apply, with the purpose of verifying and developing them, recent theories relative to electricity and to matter.

But though radioactivity is in close relation to physics and chemistry above all, it is not foreign to other domains of science, and in these acquires increasing importance.

Radioactive phenomena are so varied, their manifestations are so diverse and so widespread in the universe that they should be taken into consideration in the study of the natural sciences, especially in physiology and therapeutics, in meteorology and geology.

Many laboratories actually devote themselves to the study of radioactivity. Institutes are being created for the centralization of relatively important quantities of radium, the principal instrument of research in this new domain. And by reason of these efforts the importance of the subject must still further increase.

I published in 1903 a small volume entitled "Researches Upon the Radioactive Substances," in which was reviewed the state of the subject at that period. In 1905 appeared the excellent treatise of Prof. Ruther-

ford, which has had a more complete recent edition and has rendered great service.

In the present work I have tried to give an exposition as complete as possible of the phenomena of radioactivity, in the actual state of our present knowledge.

The plan of my first book has been preserved in part, but the work comprises a much more ample field, corresponding to the sudden development of the science.

* * *

Radioactivity is a new property of matter which has been observed in certain substances. Nothing warrants us in actually affirming that this is a general property of matter, though this opinion presents nothing *a priori* impossible, and may even seem quite natural.

Radioactive bodies are sources of energy whose disengagement manifests itself by diverse effects: the emission of radiations, of heat, of light, of electricity.

This disengagement of energy is essentially connected with the atom of the substance; it constitutes an *atomic* phenomenon; moreover, it is *spontaneous*. These two characteristics are essential.

We have actual knowledge of bodies feebly radioactive: uranium and thorium; and of many bodies strongly radioactive: radium, polonium, actinium, radiothorium, ionium.

These bodies are found in nature in an extreme state of dilution; and this is not the effect of chance. Among the strongly radioactive bodies, radium alone has been isolated in the state of a pure salt; in the richest minerals this body is found in the proportion of a few decigrammes per ton of mineral.

Radioactive substances emit rays which have the faculty of impressing sensitive plates, of exciting phosphorescence, and of rendering gases conductors of electricity; but which do not exhibit refraction, polarization, or regular reflection.

These rays offer, therefore, analogies to cathodic, positive, and Röntgen rays. An attentive examination has proved that the ray-emission of radioactive bodies can be divided into three groups, β, α, γ; respectively analogous to the three groups of rays which have just been named, and which are formed in a Crookes tube.

The β rays are constituted by an emission of negative electrons, and the α rays by an emission of particles positively charged, while the γ rays are not charged. The emission of the α rays and the β rays corresponds to a spontaneous disengagement of electricity by the radioactive bodies.

The rays of these bodies produce numerous effects of various nature: chemical effects, of which the most important is the decomposition of water; physiological effects, such as the action upon the epidermis and other tissues—an action which is currently employed for medical applications. Certain radioactive substances are spontaneously luminous.

The radioactive bodies are sources of heat. Radium gives rise to a disengagement of heat of 118 cal. per gramme per hour, and that without the state of the substance being appreciably altered during many years.

This extremely remarkable fact establishes a fundamental distinction between radium and ordinary elements, and is in accord with the actual conception which attributes radioactivity to a transformation of the atom.

The radioactive substances may possess a constant activity, at least in appearance, within the limits of our observations: such are uranium, thorium, radium, actinium. In other substances, e. g., in polonium, a slow diminution of activity in the lapse of time has been observed.

Lastly, radioactive phenomena of much shorter duration still, have been observed.

Thus, radium, thorium, and actinium disengage continuously radioactive gases called *emanations*, whose activity in time disappears; quite slowly in the case of radium, very rapidly in the case of thorium and actinium.

These emanations themselves produce on the exposed surfaces active deposits which also disappear in the course of a few hours or days. This is the phenomena of induced radioactivity.

Finally, we can, by means of suitable chemical reactions, separate from uranium or thorium radioactive substances which are continuously produced by these bodies, and whose activity disappears progressively in a few months.

All these phenomena can be explained satisfactorily

by admitting the production and destruction of radioactive matter according to precisely determined laws.

The radioactive properties are in fact very varied; the diverse forms of ephemeral radioactivity are distinguished from each other by the nature of the rays emitted, and by the rapidity of the disappearance.

It may be admitted that the production or the destruction of a distinct form of radioactivity corresponds to the production or destruction of a chemically distinct substance, and since radioactivity is an atomic phenomenon, it concerns the production and destruction of atoms.

This view constitutes an extension of ideas upon the atomic nature of radioactivity, ideas which have led to the discovery of radium.

The theory of the transformation of radioactive elements which has been developed by Rutherford and Soddy is now generally adopted.

According to this theory there exist no invariable radioactive substances, but each of them undergoes in the course of time a more or less rapid progressive destruction.

A chemically simple radioactive substance is destroyed in such a manner that the rapidity of the destruction is proportional to the quantity present. Consequently this quantity decreases according to a simple exponential law, characterized by an invariable coefficient, which depends on the nature of the substance and may serve to define it.

These coefficients, or *radioactive constants*, seem independent of experimental conditions and capable of constituting standards of time.

The destruction of atoms may be compared to an explosion, at which time fragments of the atoms may be thrown off with or without an electric charge.

The resulting products may be either inactive or endowed with radioactivity, and in the latter case the newly formed atom is not itself stable, but must submit to a new *disintegration* at the end of a longer or shorter time.

When the destruction of a form of ephemeral radioactivity occurs according to a complex law, this law can always be represented by an algebraic sum of exponential terms, which is interpreted as a succession of simple transformations of limited number. Experience has shown that in this case the various terms of the series may be considered as representing simple radioactive substances of which certain ones are capable of being separated.

In pursuing the analysis of radioactive phenomena, we succeed in establishing, starting from a primary substance, a succession of terms which succeed one another in the series of radioactive transformations.

We thus obtain families of elements allied by a relationship which connects them in a common but distinct origin. Such are: the family of radium, which comprises polonium also; the family of uranium; of thorium; of actinium.

Radium itself is not a primary substance, but probably derives from uranium. We are confronted, in fact, by the existence of about thirty radioactive elements, of which many, in truth, will never be characterized as such, because they have too brief an existence.

In fact only those radioactive elements can accumulate in appreciable quantities, of which there is a continuous production, and in which the rapidity of destruction of the quantity produced is not too great.

On the other hand, the intensity of radioactive phenomena is proportional to the rapidity of destruction; and if we compare bodies of analogous ray-emission and in similar quantities, the bodies most strongly radioactive are those which have the greatest rapidity of destruction. Hence, the most strongly radioactive substances are those which we should expect to find in nature in smallest proportions, and this is borne out by experience.

Among the products of destruction of radioactive bodies is one which is particularly interesting: the gas helium, which is produced constantly by radium, actinium, polonium, uranium, and thorium.

Experience has proved that the atoms of helium emitted should be considered as particles which have lost their electric charge.

On the other hand, the α rays of the various radioactive bodies seem constituted of the same material particles.

It results from this that the atom of helium forms, in all probability, one of the constituents of all, or nearly all, radioactive atoms, and perhaps a constituent of atomic structures in general.

The discovery of the production of helium by radium is due to Ramsay and Soddy and constitutes one of the most important facts in the history of radioactivity.

Certain radioactive transformations are very slow; e. g., the destruction of uranium and of thorium. The effects of the transformation are in these cases very insignificant even after many years.

But in the radioactive minerals these same transformations may have been produced during the process of time of geologic epochs, and hence the study of the mineral permits us to determine the relations of the radioactive bodies.

Inversely, if one such relation is known we can deduce from it the length of time during which the transformation has taken place in an unaltered mineral. Thus by the accumulation of helium occluded in minerals we can estimate the age of the latter.

If it were proved that all matter is more or less radioactive, the relative proportions of the elements in the minerals could be studied with the view of making evident the relations of genesis among the elements. To terminate this brief review of the domain of radioactivity I will indicate how great is the disengagement of energy by radioactive bodies.

Thus, for radium, whose rapidity of destruction is approximately known (this rapidity is such that the radium is half gone in about 2,000 years), the destruction of a gramme of matter involves the disengagement of a quantity of heat equal to that which results from the combustion of 500 kilogrammes of carbon or 70 kilogrammes of hydrogen.

We must conclude that the internal energy of an atom is very great in relation to that which is brought into play at the time of the combination of atoms in a molecule. This fact is probably of a nature to explain the independence of radioactive phenomena of experimental conditions.

Among the attempts which have been made to influence these phenomena, none has yet given a positive result. Radioactivity results from the destruction of certain atoms, and this destruction appears to us as a spontaneous phenomenon.

Experience shows also that everything takes place as if the probability of the destruction was, at the same instant, the same for all the atoms of the same matter. It is thus that we interpret the exponential law of the destruction and the divergences from this law.

It appears inevitable to admit that the destruction of an individual atom at a given moment results from particular circumstances which the state of this atom and the influence of exterior agents may cause to intervene.

Thus the determining cause of radioactive phenomena remains still unknown.

In this book the exposition of the phenomena of radioactivity properly so called has been preceded by an exposition of the theory of gaseous ions, and by a *résumé* of the most important knowledge concerning cathodic, positive, and Röntgen rays, and of the properties of electrified particles in motion. This knowledge is indispensable to the study of the subject in hand. A later chapter has been devoted to the description of methods of measurement.

After the detailed description of the discovery and preparation of radioactive substances comes the study of radioactive emanations and of induced radioactivity, and of radiations emitted by radioactive bodies.

The radioactive substances are afterward classified by families, with the study for each of them of the *ensemble* of properties and of the nature of radioactive transformations.

THE INTERNATIONAL RADIUM STANDARD.

HOW IT IS TO BE DERIVED.

In a recent number of Science, Mr. B. T. Boltwood reviews the work done by the International Congress of Radiology and Electricity, which met at Brussels on September 13th to 15th, 1910. The proceedings were begun by Prof. Rutherford, who stated that he had recently compared, by the γ-ray method, the radium standards employed in the leading laboratories of several different countries and had observed very considerable differences, amounting in some cases to 20 per cent, between them. He pointed out the importance of a uniform, international standard by which the results and experiments of workers in all parts of the world might be brought into accord. As the subject of radioactivity had reached a stage of development where accurate, quantitative measurements and comparisons are being constantly made, and as certain radioactive quantities, such as the number of α particles emitted by one gramme of radium, the volume of the emanation produced, and the heating effect, can now be determined with considerable precision, it is highly desirable that the necessary information as to the exact amount of radium in any given specimen of the substance should be definitely and readily determinable by different workers. It was therefore suggested that a specimen of the purest obtainable salt of radium should be prepared and accepted as an international standard and that facilities be afforded by which all workers in the science might be able to express their results in terms of that standard. The subject was generally discussed, and it was finally decided that a committee, to be appointed by Prof. Rutherford and Mme. Curie, should be formed and that this committee should consider the special needs in the matter and determine the conditions under which the standard should be prepared and preserved. After some deliberation the committee was announced and consisted of Mme. Curie and M. Debierne for France, Professors Rutherford and Soddy for Great Britain, Prof. Geitel and Dr. Hahn for Germany, Professors St. Meyer and von Schweidler for Austria, Prof. Boltwood for the United States, and Prof. Eve for Canada. It is probable that representatives of other countries who are willing to assist in the work will be added later. An address was then given by Mme. Curie on the subject of her recent experiments on the preparation of metallic radium. No formal action was taken on the subject of nomenclature, but it was agreed that the present system of nomenclature, though far from perfect, was to be preferred to a possibly more rational system which would involve a general change in the names now given to the radioactive substances and would lead to much confusion, for which the advantages obtained would scarcely compensate. The present system affords opportunities for including new products which may be later discovered. Thus, if future investigation should prove that the product radium C is complex and consists of several separate substances, these can be called radium C_1, C_2, etc., and the term radium C can be retained for the mixture of the several separate products which normally occur together. It was also suggested that the term "half-value period" should be used to express the time required for any given radioactive product to become half transformed into other substances and that the expression "active deposit" should be used in place of the terms "induced" and "excited" activity.

These proposals were received with general approval. On the following day the congress met in three sections in which a large number of interesting papers on the physical and medical aspects of radiology were presented. On the last day so many important papers remained to be read that it became necessary to subdivide the meetings still further and a separate section was formed for the consideration of purely radioactive questions. Unfortunately, the number of papers were so great that by the system under which the meetings were conducted, insufficient time was available for the proper presentation of a large number of papers. In fact the general arrangements for the meetings were not altogether satisfactory and some dissatisfaction was expressed at the close at the way in which the affair had been managed. From the standpoint of general usefulness, however, the congress was a great success, as it afforded an excellent opportunity to all who attended to become acquainted with other workers in their own special lines. The arrangements for the time and place of the next congress were placed in the hands of an international committee, and it is to be hoped that another gathering can be effected in the near future.

The International Committee on Standards reported at one of the last meetings and its recommendations were formally adopted. The substance of the report was as follows:

1. Mme. Curie has kindly agreed for the purposes of the standard to prepare a quantity of the purest obtainable anhydrous radium chloride containing about 20 milligrammes of radium (element).

2. When the committee has reimbursed Mme. Curie for the cost of the radium standard, this will come under the control of the committee and will be used only for the measurement and comparisons of secondary standards by means of the γ-rays. The original standard is to be suitably preserved and deposited in Paris.

3. Through the committee and at its discretion national scientific laboratories and bureaus of standards willing to pay the costs are to be provided with certified secondary standards.

4. By such methods as, after due consideration, meet with the approval of the committee smaller subsidiary standards are to be prepared for distribution.

5. As radium emanation is now so generally used in scientific investigations, the committee considers the adoption of a unit for the measurement of the amounts of radium emanation desirable. The committee recommends that the name "Curie" be given to the quantity or mass of emanation in equilibrium with one gramme of radium (element). The millicurie would thus be the amount of emanation in equilibrium with one milligramme of radium.

6. The question of proposing special names for units of measurement of minute quantities of radium and its emanation is under consideration, but no definite conclusions have as yet been reached.

7. As some members of the committee were not present at the Brussels Congress, and as it has not been possible to obtain information as to their views on these questions, the recommendations here made are not necessarily final. The committee reserves the power to modify them if on further consideration this appears to be desirable.

The preparation of a standard specimen of a pure radium salt is thus assured. The committee was fully agreed that by placing the matter in the hands of Mme. Curie the most satisfactory and trustworthy results could be attained. Mme. Curie has accepted the full responsibility, and this portion of the work will be entirely under her personal charge. The methods which will be used by her are left entirely to her discretion. It will be necessary for the committee to approach their several governments or the scientific societies of the different countries interested to secure the funds necessary to defray the cost of the primary standard, which at the present price of radium will probably be about £2,500. It may at first sight appear that the amount of radium in the primary standard, viz., about 20 milligrammes, is unnecessarily large, but it was pointed out by Mme. Curie that the acurate weighing of quantities less than the amount mentioned of such a relatively unstable salt as anhydrous radium chloride could not be satisfactorily accomplished. The later or secondary standards will be calibrated by comparison with the primary standard, making use of the γ radiation emitted by the radium salts. It will probably be possible to do this satisfactorily if the secondary standards contain a somewhat smaller amount of radium than the primary. It is anticipated that about 10 milligrammes of radium will be a sufficient amount for a secondary standard. These secondary standards will be compared as stated with the primary and also with one another, before their distribution, and it will thus be possible for each country to have in its possession, and at its disposal, one of the secondary standards which may be used for the measurement and certification of quantities of radium when desired. The advantages of this arrangement would seem to be clearly apparent. Not only will it be possible for the scientific results obtained in the subject of radioactivity in different countries to be brought into complete accord, but individuals interested in either the sale or purchase of specimens of radium salts can then be able to obtain trustworthy data as to the amounts of radium in the specimens involved in the transaction. Great uncertainty has existed in the past in the latter cases. Many people have made purchases at high prices only to discover later that the radium salts which they had bought were far from pure. As probably more than $500,000 worth of radium preparations have already been sold in this country it will be seen that some definite standard of quality and value is imperative for the protection of all concerned.

The problem of the preparation of small substandards containing one or two milligrammes of radium, suitable for the use of most scientific laboratories, is one of the most difficult which the committee has to consider. By means of the γ radiation it is not difficult, with proper precautions, to compare approximately equal quantities of radium with an error of considerably less than one per cent. But when the amounts of radium to be compared differ by a ratio of ten to one the problem is much more complicated. As attention will now be devoted to this matter, it is probable, however, that methods will be devised for conducting comparisons of this sort with the degree of accuracy required and to calibrate the smaller

substandards by direct comparison with the primary standard or, at all events, with the national standards of approximately ten milligrammes or so. A further matter which has to be considered is the preparation and distribution of extremely dilute solutions of radium salts. For many scientific purposes, such as the determination of the radioactivity of natural waters and rocks, standard solutions of radium containing a definite, known amount of radium per cubic centimeter are frequently required. The committee proposes later to have prepared under its direction standard solutions of this kind, the strengths of which are known in terms of the primary standard. It will

probably be some time before these solutions are ready for distribution, and as it may be of considerable assistance to workers in radioactivity to have some working standard for their present uses, the writer will be glad to furnish to those who may now require it small quantities of the solution prepared by Eve, Rutherford, and Boltwood.* The strength of this solution is accurately known in terms of the radium standard in the possession of Prof. Rutherford. When the new international standard has been prepared, the Rutherford standard will be compared with this,

---

* Am. Jour. Sci. (4), 22, 1, 1806.

and any results obtained by the use of the present solution can then be corrected in terms of the international standard.

It is to be hoped that the International Radium Standards Committee, in its efforts to place radioactive measurements on the same accurate basis as electrical and other measurements, will be supported financially by the governments of the countries represented. All questions with regard to the international radium standard should be addressed to Prof. Stefan Meyer, the secretary of the International Committee, Institut für Radiumforschung, Waisenhausgasse 3, Vienna IX., Austria.

FOUR RECENT TYPES OF DREADNOUGHTS.*

A DISCUSSION OF THEIR COMPARATIVE MERITS

BY LUIGI BARBERIS,
CAPTAIN CORPS OF CONSTRUCTION, ROYAL ITALIAN NAVY.

SINCE the promotion of Sir Philip Watts to the post of Chief Constructor of the British Navy, there have been introduced into the service of that great marine many innovations, good and otherwise. Among them one which has excited an infinite number of protests and criticisms; that is, the principle of secrecy regarding the plans for new construction.

Other navies follow more or less the example of England; and for several years the reviews, annuals, and naval almanacs have been giving incomplete and inexact vignettes of dreadnoughts of various nations.

In the last few months, however, by a set of curious circumstances, there have come to light the schematic designs of four types of the most recent dreadnoughts, none of which ships has yet been launched. These plans have every appearance of authenticity, and are derived from such reliable sources that, although they are neither official nor semi-official, they may be considered sufficiently trustworthy to merit attention.

These four types of dreadnoughts are:

a. The "Sebastopol" class, Russians, to which belong the "Petropavlovsk," the "Gangut," and the "Poltava"; laid down with great pomp simultaneously on June 15th, 1909, at the Baltic works and the Obukoff yard.

b. The "Wyoming" and the "Arkansas," Americans; the contract for the former was awarded to Cramps on October 14th, 1909; that for the latter to the New York Shipbuilding Company on September 25th of the same year.
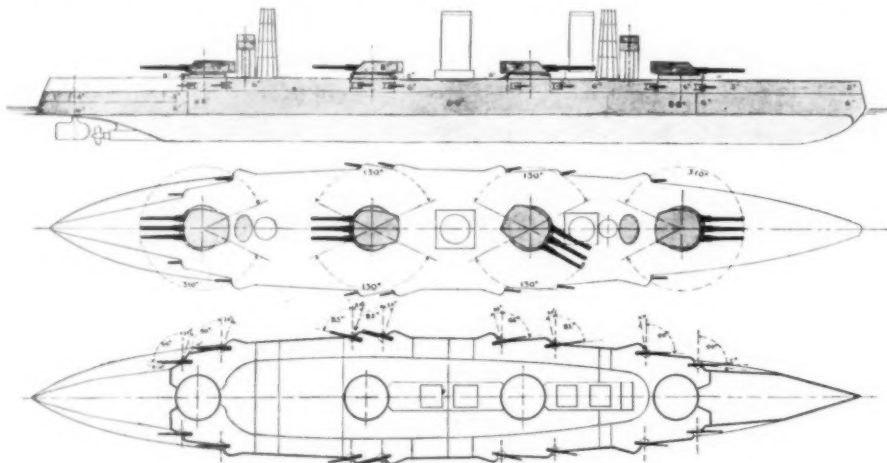
c. The "Rivadavia" and "Moreno," Argentines, awarded to the Fore River Iron Works on January 21st, 1910. (Contract for one of these was sublet to the New York Shipbuilding Company.)

d. The "Jean Bart" and the "Courbet," French, whose plans were finally approved by the Ministry April 16th, 1910, and turned over to the Brest and Lorient dock yards on the 7th of May.

lative to new construction must be made public in parliamentary documents.

The Moniteur de la Flotté of June 11th, which published the details and vignettes of the "Jean Bart," en-

Displacement, 23,000 tons. Speed, 22.5 knots. Maximum coal supply, 3,000 tons. Armor: Belt, 8¾ inches to 6 inches; turrets, 8 inches. Armament: Twelve 12-inch; sixteen 4.7-inch. Torpedo tubes, none.

RUSSIAN "SEBASTOPOL."

joys such a reputation for reliability and close connection with current affairs that we cannot doubt the exactitude of its information.

The best information concerning the "Wyoming" appeared in a notable article in the June, 1910, number of The Navy.

The sketches and data concerning the four Russian

Displacement, 27,533 tons. Speed, 23 knots. Maximum coal supply, 4,000 tons; 960 tons oil. Armor: Belt, 12 inches to 4 inches; turrets, 9 inches. Armament: Twelve 12-inch; twelve 6-inch; twelve 4-inch. Torpedo tubes, two 21-inch.

ARGENTINE "RIVADAVIA."

FOUR RECENT TYPES OF DREADNOUGHTS.

The publication of the plans of the French and the American ships is scarcely cause for surprise, for in addition to the liberality usual to these two navies, there are certain legislative reasons why the data re-

battleships are taken from an exhaustive article in Engineering of May 20th, 1910. This journal is too well known to allow of our questioning the source from which it derived its facts; and their authenticity is further substantiated by the lively comments provoked in Russia by their publication.

As to the Argentine vessels, a sufficiently ample description appeared in the official Boletin del Centro Naval in its January, 1910, number; but other details have also come to hand in Argentine (La Nacion) and foreign (SCIENTIFIC AMERICAN) papers, which we have every reason to believe are thoroughly dependable.

It is interesting to examine somewhat carefully into the origin of the drawings and descriptions which have repeatedly appeared in numerous technical publications (including the Rivista Marittima), because in order to comment on the plans of the several projected vessels and compare their points of difference, it is essential that the authorities cited shall be as near absolute as possible.
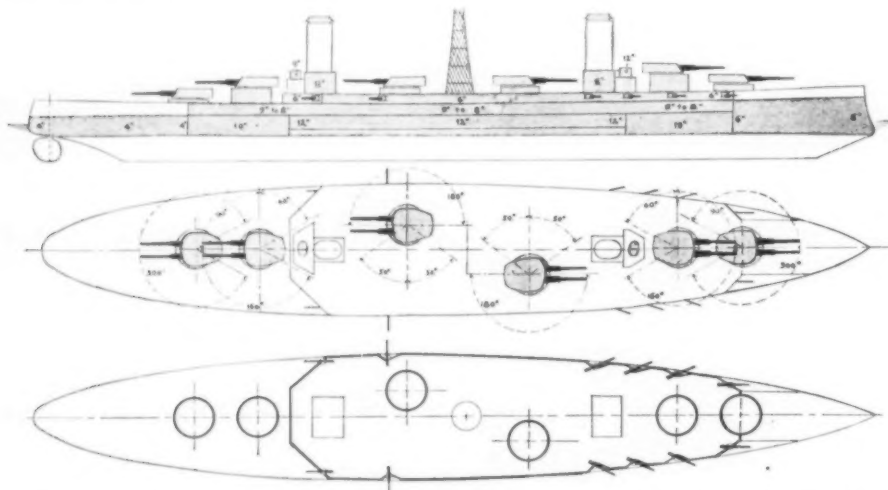
The four designs are not quite contemporaneous, and it should be noted that the Russian dates from the spring of 1909, the American from that summer, and the French and Argentine from the end of that year.

MAIN ARMAMENT.

The comparison of the main batteries of the four dreadnoughts which we are considering is made particularly easy and interesting by the fact that all the ships carry twelve 12-inch (305-millimeter) guns.

The first thing that strikes the reader after a glance at the accompanying diagrams is that the French have sacrificed one-sixth of the gun power of their ships in the sector of maximum offense (the broadside) merely to reinforce the bow and stern fire. It stands to reason that during the greater part of a fight one of the flank turrets of the "Jean Bart" would remain perfectly useless. Even in those few moments in which the ship would have occasion to fire in chase or in retreat, the ballistic efficiency of the vessels would not be eight guns (as it might at first sight appear, and as the Moniteur de la Flotte erroneously maintains), but six, as shown clearly in the diagram. The solution adopted in the Argentine navy proves that it is possible by other means to get the fire of six guns along the line of the keel while still conserving all twelve for use on the broadside.*

The Americans seem content with a fore and aft

---

* Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Rivista Marittima.

* An idea of the sacrifice made by the Frenchmen may be got by taking the sum of the arcs of fire of the individual guns and dividing by twelve. Thus: "Rivadavia," 293 deg.; "Wyoming," 288 deg.; "Sebastopol," 285 deg.; "Jean Bart," 243 deg.

fire (within 15 degrees each side of the keel line) of but four guns, and the Russians have only three which can fire end on within 25 degrees of the longitudinal axis. The latter, however, have made up for the loss of end-on efficiency by a splendid broadside fire of all twelve guns throughout an arc of 130 degrees (according to Engineering). Amazing as it may seem, the Yankees have not taken advantage of the splendid system which they first introduced, and have contented themselves with a maximum arc of but 95 degrees,

Displacement, 25,298 tons. **Speed,** 20.5 knots. **Maximum coal supply,** 2,500 tons; 400 tons oil. **Armor:** Belt, 11 inches to 5 inches; turrets, 11 inches. **Armament:** Twelve 12-inch; twenty-one 5-inch. **Torpedo tubes,** two 21-inch.

UNITED STATES "WYOMING."

only slightly different from that of the French (90 degrees) and Argentine (100 degrees) ships. This seems all the more remarkable because America gave us the classic commentary of Commander Niblack, in which the importance of an ample arc of maximum offense was ardently upheld, not only by Commander Niblack, but also by Rear Admiral Wainwright and Commander Sims.

However, if the Americans have been able to give to turrets Nos. 4 and 5 a range of 75 degrees fore and aft of the beam—a maximum never before achieved—we may assume that they must have had good reasons for limiting to 45 and 50 degrees the range of Nos. 2 and 3, respectively.

TORPEDO-DEFENSE ARMAMENT.

It is a pity that the sketch in The Navy did not indicate the disposition of the twenty-one 5-inch guns of the American ships, although it is reasonably certain that sixteen of these are in casemates on the gun deck, and one in the stern.

The sixteen 4.7-inch (120-millimeter) of the Russian battleships are placed in battery on the gun deck.

Of the twenty-two 5.5-inch (140-millimeter) guns on the "Jean Bart," eighteen are in an armored redoubt on the main deck in a prolongation of the forecastle, and only four are on the gun deck.

The twelve 6's of the "Rivadavia" are contained in a redoubt similar to that on the "Jean Bart," but the location of the twelve 4's is not definitely known.

The French and the Argentines have given the problem of torpedo defense a highly modern solution. Therefore it seems strange that the American design has retained the 5-inch on the gun deck especially after this location had been condemned at the Newport conference of July-August, 1908,* where the report of Engineer Robinson (with comments by Rear Admiral Evans) made after the round-the-world cruise of the fleet, caused great discussion and no end of argument. And the most surprising thing of all is that Robinson was Capps's most active collaborator in preparing the plans of the "Wyoming."

The distribution of the arcs of fire on the Frenchmen is far from ideal, and in all probability this may be said of the other three types as well. The French have only three pieces in the part of the ship most vulnerable to attack, namely, forward; on the other hand, they have an unnecessarily large number (eleven) in broadside. In the "Rivadavia" only one, or at most two, of the 6's can fire along the line of the keel. From this point of view the "Sebastopols" are better off, where by means of an old and little-praised artifice—well-rounded sponsons—four guns on each side have a bow or stern fire.

The French idea of arming the after part of their men-of-war more completely than the bow is rather surprising in view of the findings of our Commander Vannutelli, R. I. N., after considerable analytic study. These are that under an attack by torpedo craft, the shorter period of time in which firing is feasible at the forward end of the ship necessitates the concentra-

* Resolution No. 3, carried by 50 votes to 11, stated: "That the 5-inch battery of the "North Dakota" is too low to be used efficiently in ordinary trade-wind weather."

tion there of the majority of the secondary guns.

As to the choice of calibers, there is not much room for argument. Certainly one would not have expected that the Argentines, having frankly adopted the principle of a uniform caliber for their main battery, would not follow the lead of other navies and adopt it for the anti-torpedo battery.

SUBMARINE ARMAMENT.

The "Jean Barts" have four under-water torpedo tubes, but these are still only 18-inch, like in the earlier French ships. The "Wyomings" and "Rivadavias" are fitted with but two tubes each, but of 21-inch diameter. In the "Sebastopols" the torpedo tubes have been altogether omitted, so we thus see all the modern tendencies represented.

FREEBOARD AND HEIGHT OF GUNS.

The "Rivadavias" and the "Jean Barts" are designed with a topgallant forecastle which extends aft for about two-thirds of their length, the after part forming the armored redoubt for the secondary battery guns. In the "Jean Bart" the freeboard at the bow is 23½ feet; amidships, 22½ feet, and little more than 16 feet at the stern. The "Rivadavia's" bow is 26 feet above the waterline; her freeboard is 23 feet amidships and 17 feet aft. Notice that the Argentine ships have been given a considerable sheer.

Concerning the "Wyoming," the data are somewhat mixed, the sketches in The Navy and The Army and Navy Register not showing any topgallant forecastle, as have the "North Dakotas" and "Utahs"; on the other hand, the text gives the height of the forecastle at 24½ feet, while the freeboard amidships is 21½, and aft 18¼ feet. We may safely say that there is no topgallant forecastle; but we cannot understand how the poop can be so low unless it has one deck less, for we notice that the height of the quarter-deck guns is given as 25¼ feet, which should denote (if the plan of the "Utah" is followed) a freeboard aft of about 21½ feet.

The "Sebastopols," according to Engineering, appear to have one continuous deck from stem to stern, with about eighteen feet of freeboard.

Upon examining these figures, we are struck with the fact that all these ships are exceedingly long and low in the water. They are all—especially the Frenchmen—lowest at the after end. In Italy, where we have just begun, in the "San Giorgio," to pay attention to high freeboard (which has been retained in the "Dante Alighieri" and "Giulio Cesare") this point might perhaps with profit be discussed. A diminution of two or three feet in the height of the ship's sides not only effects a very considerable economy in the weight of the hull and armor, but also reduces the probability of being hit at long range. It might even give, according to computations already made, an added defensive power equal to a noticeable increase in the thickness of the side armor.

The heights of the axes of the various guns on the four ships above the water are as follows:

	Rivadavia, Feet.	Wyoming, Feet.	Jean Bart, Feet.	Sebastopol, Feet.
Turret No. 1	32	30	31	29 (about)
Turret No. 2	40	37	38	29 (about)
Turret No. 3	32	34	25	29 (about)
Turret No. 4	32	27	25	—
Turret No. 5	32	32 1/3	28½	29 (about)
Turret No. 6	22½	25	21 1/3	29 (about)

Above a certain amount, from 25 to 26½ feet, the advantages of height above the water level are no longer felt, hence the frugality displayed by the French in this regard appears wise. If the height of the battery had any great military significance, the wisdom of the Russian plan would become apparent—that is to say, all guns the same height without sacrificing any of them.

Concerning the torpedo-defense guns, the only data we have concerns the "Rivadavia's" 6's, which are 19 1/3 feet above the water, and those of the "Jean Bart," 19 feet, except the four stern guns, which being only 12 feet above the water will hardly ever be able to be fired.
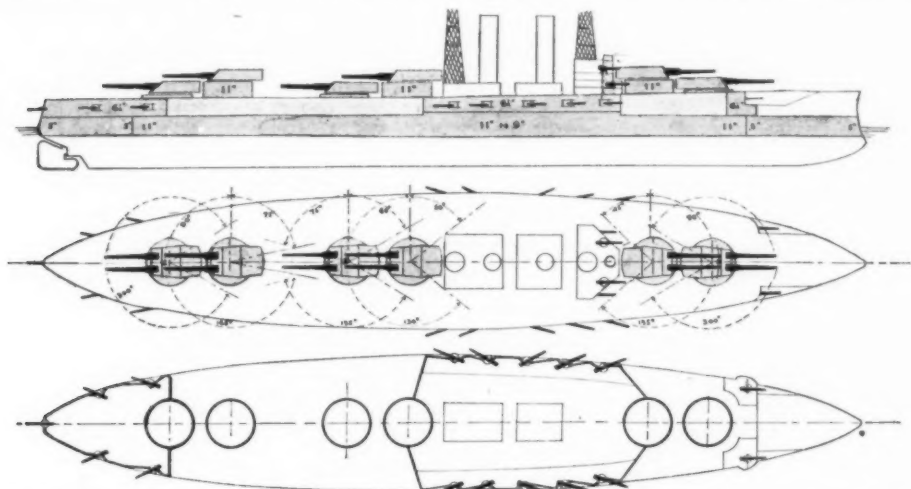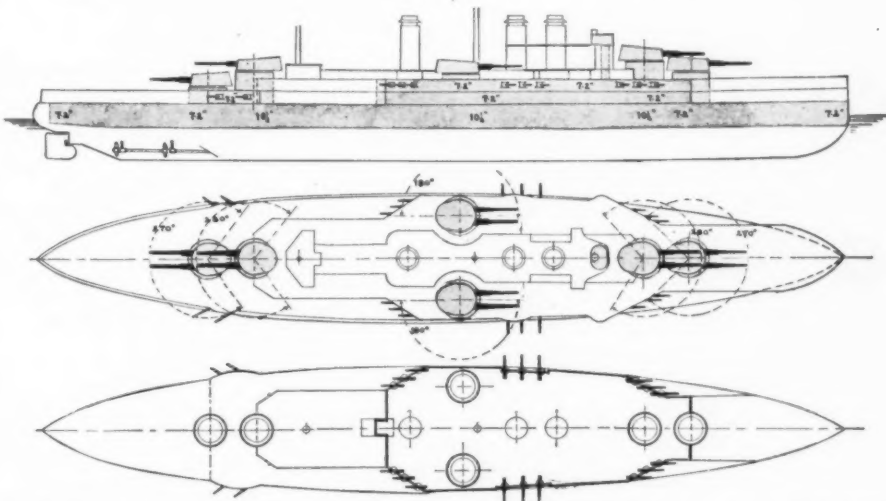
VERTICAL PROTECTION.

The Argentine vessels have the thickest armor belts. For some 250 feet amidships the "Rivadavia's" main belt has a thickness of 12 inches, and rises some 4½ feet above the normal water-line. Eighty feet forward and 70 feet aft of this main belt the plates are 10 inches thick, and thence to the bow and stern measure 6 and 4 inches, respectively.

In the Americans the width of the main belt above and below the water-line is about the same; the part protecting the ship's vitals is 400 feet long and 11 inches thick, which is gradually reduced to 5 inches at the extremities.

The belt of the "Jean Barts" extends upward from the load-line for 7¾ feet with a thickness amidships of 10¾ inches, tapering to 7½ at the ends, but we do not know just how long the main belt is.

In the Russians the armor is 8¾ inches thick for 370 feet amidships, the top of the belt being about 10 feet above the water-line. Fore and aft it is of 6-inch steel. There is, moreover, one peculiarity; at a distance of about 11 feet from this belt, on either side of the ship, is a vertical wall of 3 to 4-inch armor. "Would not this weight be better utilized," says Engineering, "if added to the main outside belt?"

Displacement, 23,323 tons. **Speed,** 20 knots. **Maximum coal supply,** 2,700 tons. **Armor:** Belt, 10¾ inches to 7½ inches; turrets, 10¾ inches. **Armament:** Twelve 12-inch; twenty-two 5.5-inch. **Torpedo tubes,** four 18-inch.

FRENCH "JEAN BART."

FOUR RECENT TYPES OF DREADNOUGHTS.

The upper deck sides of the Argentine ships are protected by plates ranging from 9 inches at the bottom to 8 at the upper edge. These extend fore and aft for 400 feet. Forward to the bow is 6-inch armor, and only at the very stern is the ship's side unprotected. The main deck redoubt has 6-inch covering, except the

extreme forward part of the topgallant forecastle.

The French as usual are more conservative in extending the armored surface. This reaches the main deck only for a distance of 206 feet amidships, and for another 36 feet in the wake of the two quarter-deck turrets—in all, 242 feet. Besides the main-deck redoubt is armored for 206 feet, but all this upper side armor is of the modest thickness of 7 inches (178 millimeters); hence the gun deck is less well protected than in the Argentines, but the main-deck redoubt more so.

The "Wyoming's" heavy belt only extends to the gun deck—9 inches above the main belt for 400 feet. The space between the gun deck and the main deck has 6.6-inch plates only.

The upper strakes of the Russian ships are 6 inches thick in the middle and 3 inches at the bow.

From these data we are enabled to compile the following table, which gives an approximate idea of the percentage of side of the respective ships covered with armor, together with the percentages of the various thicknesses:

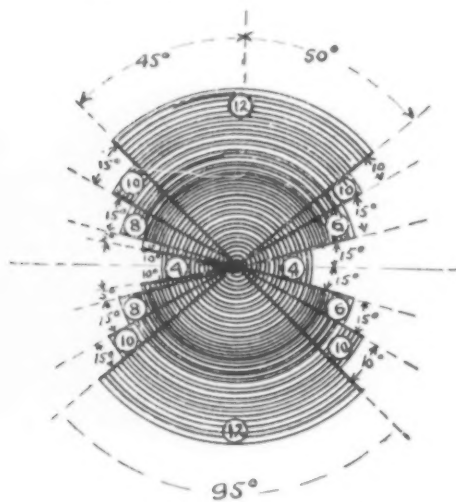|	"Rivadavia."		Per cent.
1,130	square feet of	12-inch, or	8.5
700	do.	10-inch, or	5.5
5,000	do.	8.5-inch, or	39.0
3,981	do.	6-inch, or	30.5
538	do.	4-inch, or	4.0
1,668	do.	......, or	12.5

13,017 square feet.

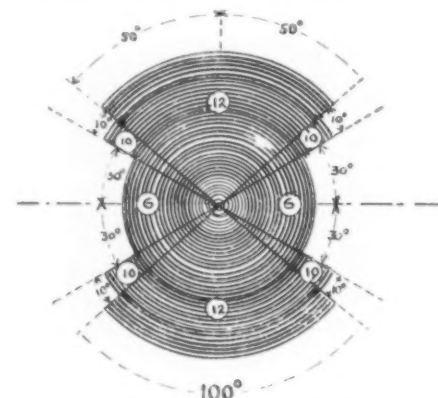|	"Jean Bart."		
2,636	square feet of	10.3-inch, or	22.0
5,972	do.	7.2-inch, or	51.0
3,326	do.	......, or	27.0

11,934 square feet.

	"Wyoming."		
1,829	square feet of	11-inch, or	16.0
3,272	do.	10-inch, or	29.0
967	do.	6.6-inch, or	8.0
5,380	do.	......, or	47.0

11,448 square feet.

tion against armor-piercing projectiles and another for defense against common shell.

The turrets of the Americans are (probably only the face plates) 11 inches thick; 10½-inch for the French; 9-inch for the Argentines; and only 8-inch for the Russians. The latter's conning towers are 11 inches, against 12 in the others. The "Rivadavias" have 1½ inches (38 millimeters) on their funnel casings for a height of about 16 feet above the main deck; we doubt the efficiency of such thin armor.

HORIZONTAL PROTECTION.

The Argentine battleships are said to have two protective decks—one of 1½ inches, which is probably the main deck (except at the stern, where it would be the gun deck) and another deck below, which is 3 inches (75 millimeters) thick.

Regarding the American ships, the SCIENTIFIC AMERICAN says that there is only one protective deck, 2 inches thick. In the wake of the magazines, however, there is another of the same thickness.

France, the country of aeroplanes and dirigibles, has, according to the Moniteur de la Flotte, given her

ARGENTINE "RIVADAVIA."

SPEED.

In the matter of speed we find adherents of two schools. The Russians and Argentines belong to one, the French and Americans to the other. The "Rivadavias" are to have 23 knots' speed with 42,000 horse-power; the "Sebastopols" 40,000 horse-power is to drive them at 22.5 knots. The Americans and the Frenchmen are most modest, being contented with 20.5 and 20 knots, respectively, with 28,000 horse-power each.

It is rather remarkable that the American "Delaware" and "North Dakota," designed in 1907, were given 21 knots' speed, which was reduced in the "Florida" and "Utah" to 20.75; and now, as we have seen, the "Wyomings" are to have even ¼ knot less. This looks like a premeditated sacrifice, but it should be remembered that the contract speed is to be attained with 1,964 tons of coal on board.

Engineering, in a somewhat unfavorable criticism of the Russian ships, finds these 23 knots totally unnecessary. This is one of the most fruitful fields of dispute among naval architects, and it shows little likelihood of dying out. One thing seems certain—the increase in the speed of battleships is slow but sure, and all must come to 23 knots sooner or later. Therefore those navies which build few ships must keep a step or two in advance, so as not to be left behind in the race for supremacy. There is no doubt but what the Russians might have saved 2,000 tons of displacement, and the Argentines at least 3,000, by contenting themselves with the speed of the "Wyoming" or "Jean Bart."

COAL CAPACITY.

The Argentines have inaugurated a new departure, in that they have given their ships a coal capacity proportionate to their displacement. This seems logical enough; but all the nations have hitherto followed the example of England, who had given the original "Dreadnought," and even the "Neptune" of 20,000 tons, the same normal coal supply (900) as had the old "Duncan" of only 14,000 tons displacement.

The French have clung to the "normal" 900 tons, with a maximum of 2,700, as in the "Patrie" class. The Americans (2,500 tons coal and 400 oil) have hardly improved in this respect over the "New Hamp-
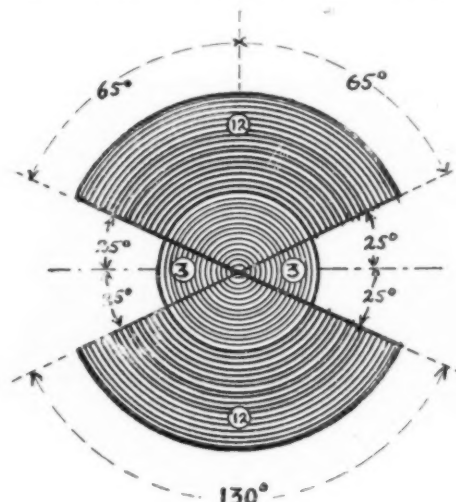

UNITED STATES "WYOMING."

FRENCH "JEAN BART."

RUSSIAN "SEBASTOPOL."

Figures in circles show number of guns that can be concentrated within the respective shaded areas of fire.

DIAGRAMS SHOWING ARCS AND CONCENTRATION OF FIRE OF 12-INCH GUNS.

	"Sebastopol."		
3,658	square feet of	8.7-inch, or	31.5
5,972	do.	6.0-inch, or	51.5
1,076	do.	3.0-inch, or	9.0
915	do.	......, or	8.0

11,621 square feet.

From an inspection of these tables we find that the Russian and Argentine ships conform more closely than the others to the modern idea of having a great portion of the side protected by armor. In fact, even if we should consider as unprotected the parts covered by 4-inch or less, there would still remain in these two types some 83 per cent armored with 6-inch or over. Of this 83 per cent, however, the Argentines have three-eighths of 6-inch and five-eighths of 8-inch or better; while for the Russians the figures are just the reverse. While admitting that the South Americans are very well protected, it must be said that the 12-inch covers a very limited zone.

As to the protection of the French and the American vessels, the latter are indeed somewhat the better off in this respect, but still not the equal of the Argentines.

Until the time comes when all nations shall have adopted a uniform projectile against which but one kind of armor shall be used, we think the French idea seems rational; that is, one thickness for protec-

ships three armored decks. The uppermost of these is of 1.2-inch (30-millimeter) steel; the middle one of 1.95-inch (48-millimeter); and the lowest of 2.78-inch (70-millimeter). Aside from the fact that it is difficult to guess just where these decks are located, it would seem a bit premature at this time to trouble about explosives hurled from above; and M. Lyasse is too able an engineer to waste so much tonnage on over-heavy protective decks.

Engineering makes no mention of the deck armor of the Russian vessels.

UNDER-WATER PROTECTION.

The problem of protecting the under-water bodies of these four types of dreadnoughts has been attacked by the various designers in divers ways. The Argentines have devoted 670 tons of steel to internal protection, in the shape of armored bulkheads an inch thick and some 10 to 12 feet inboard from the vessel's sides; and also in 0.7-inch (18-millimeter) plates under the engines and magazines.

The French had a rather unhappy experience with a caisson built at Lorient on the model of the "Mirabeau," which led to an acrimonious discussion in the Board of Inquiry as to the waste of 2,700,000 francs ($521,000) on each of the six "Dantons." Therefore in these later ships they have abandoned completely the idea of armored protection against submarine attack. The Russians also have given it up.

shire"; the increased amount of coal carried by the "Wyoming" on the trial trip merely resulting in a greater draft and a correspondingly reduced speed.

The Argentines, on the other hand, have adopted a bunker capacity of hitherto unheard-of magnitude; their normal supply being 1,600 tons out of a total of 4,000 tons of coal and 660 of oil fuel. We need not dwell on the immense advantage this gives the South American vessels, but we call the reader's attention to the necessity for wide radius of action in ships of a nation bordering on the ocean. On the other hand, those which like the Austrian "Radetskys" (14,500 tons, 1,350 tons coal) are less well supplied with fuel, are not therefore to be considered inferior in design, but rather the more fortunate in belonging to a navy which operates in the confined waters of the Mediterranean.

DISPLACEMENT.

To make a fair comparison of the displacements of the various types we must first put them all in the same condition with regard to coal, etc. In France they consider the normal coal supply one-third of the maximum; in Argentina, 40 per cent; and in the United States, two-thirds, besides two-thirds of the oil fuel.

Taking one-third of the maximum as the normal in each case, we find the several displacements somewhat as follows:

"Rivadavia"* .... 27,533 tons (with 1,333 tons of coal)
"Wyoming" ...... 25,298 tons (with 845 tons of coal)
"Jean Bart" ...... 23,323 tons (with 900 tons of coal)

As we do not know the coal capacity of the "Sebastopol," we shall take the displacement given in Engineering, which is 23,000 tons.

The fact that the Argentines displace 2,235 tons more than the Americans can be accounted for when one considers that the extra 12,000 horse-power weighs 800 or 900 tons; and the 670 tons of under-water armor and 500 tons more of coal not only account for the rest of this discrepancy, but prove either that the Argentines are far more economically designed or that the American plans are needlessly extravagant. At any rate, it is apparent that the South American ships are better protected (their armor weighs 7,500 tons to 6,492 tons for the "Wyomings"); and have the advantage of a topgallant forecastle with a main deck redoubt, which latter, in spite of the loftiness of the "Wyoming's" decks, gives the former an average of about 20 inches more freeboard.

Wherefore it may be said with some degree of assurance that had the United States ships been designed with the same skill as the Argentines, they would have had from two to three thousand tons less displacement. And we may draw similar conclusions from a comparison between the "Wyoming" and the "Jean Bart," which have about the same speed, freeboard, and protection, while the latter's twenty-two 5.5-inch guns certainly outweigh the American's twenty-one 5's.

As for the Russians, it looks as if the utmost possible had been accomplished on a moderate tonnage. The three-gun turrets show some economy (about 300 or 400 tons, with the barbettes all on the same level); but their low freeboard and relatively thin armor do not quite explain how they get 23 knots on a displacement of only 23,000 tons. Nevertheless, the hulls seem to have been designed so as to give, if not robustness, at least lightness and rigidity.

DIMENSIONS.

In giving the draft of the several vessels we shall take the normal displacement as given in the preceding table. The lengths cited below are fairly accurate, and refer to the distance between perpendiculars, after the English fashion.

	Length Between Perpendiculars. Ft.	Breadth. Ft. In.	Draft. Ft. In.
"Rivadavia"	604	96 ..	26 9
"Wyoming"	540	93 3	27 6
"Jean Bart"	541	88 7	29 ..
"Sebastopol"	566	89 ..	27 3

Granting the inestimable value of moderate draft, we must concede that the Argentines have solved the

---

* The various ships all carry about the same amount of ammunition. The "Jean Bart" has a normal supply of 100 rounds per 12-inch gun and 275 for each 5.5-inch; the "Rivadavia" carries normally 80 rounds for the big guns (but with magazine capacity for 120), 300 6-inch and 350 4-inch; the Americans carry the same number, at least for the 12's. About 144 tons of the "Jean Bart's" displacement are accounted for by the greater weight of her 12-inch shells (968 pounds) and powder charges (350 pounds).

problem brilliantly; but to make the comparison thoroughly fair, let us expand all four displacements to a common unit (that of the "Rivadavia") and see what the result will be. Note that the dimensions have been altered according to the laws of similitude.

		Length Between Perpendiculars. Ft.	Breadth. Ft. In.	Draft. Ft. In
"Rivadavia"		604	96 ..	26 9
"Wyoming"	Raised to 27,533 tons	554	96 2	28 4
"Jean Bart"		574	93 10	30 8
"Sebastopol"		601	94 2	29 ..

Thus we see that, as was to be expected, the two fastest types have the greatest length; the Americans are shortest and broadest; while the Frenchmen draw the most water, and this is perhaps their worst defect.

SUMMARY.

The opinions expressed herein were of necessity more or less subjective, although after closely studying the four types of dreadnoughts some few conclusions are sufficiently evident to make their acceptance a matter of course. The French ships are palpably inferior to the others in offensive force, while the Russian disposition of armament far outclasses the others. The advantages of an arc of maximum efficiency of 130 degrees are so enormous that we must hand them the palm, no matter what defects we may think we see in their triple turrets. The adversaries of this arrangement of guns make the most of two drawbacks, viz.: "Too many eggs in one basket" and weakness in fore-and-aft gunfire.

Concerning the first disadvantage, it may be said in rebuttal that the Russians have obtained an unusually large amount of independence for the individual turrets, which are located in four widely separated parts of the ship, 116 feet between centers. With the turrets superposed, or placed close to one another, as in the other three designs, there is always an excellent chance for one lucky shot to disable a great proportion of the armament. From this point of view it looks as if the Russians had put their study to the best account.

To realize, on the other hand, of how little importance is the sacrifice of end-on fire, one need but to examine the diagrams of the most important battles of the late Russo-Japanese war.

For the two battles of the 10th of August, 1904, we quote the official Japanese reports. In the first action, which lasted some 125 minutes, from 1:15 till 3.20 P. M., the duration of time in which the volume of fire of the Japanese was at its minimum was only 8 minutes, as against 117 minutes during which their ships were able to show their greatest offensive fire. These figures were respectively 20 and 105 minutes for the Russian squadron. Both sides, then, were able to concentrate their maximum gunfire for about 90 per cent of the action. In the second encounter, which began at 6:15 P. M. and ended at 7:10—or about 55 minutes—both the Japanese and the Russians maneuvered their vessels so as at all times to present to one another their greatest arcs of fire.

For the details of the battle of Tsushima we are

indebted to the diagram and description of the American naval officer White, which, taking it all in all, has remained one of the most reliable commentaries on that battle. The fight lasted from 1:55 in the afternoon until 4:15, some 140 minutes. During this action the Japanese fired end-on for a little less than 15 minutes, the Russians for as much as 30. All the rest of the time the ships were broadside to each other.

Rear-Admiral Wainwright, U. S. N., was altogether right when he said that the greater part of every sea fight would take place with the ships firing between the angles of 45 and 135 degrees from the bow; and that a fair percentage of the remainder of the time would see the firing between 20 and 45 degrees and 135 and 160 degrees; with the negligible balance for end-on fire.

It would appear from actual experience in the Russo-Japanese war that this minimum is fixed at between 10 and 15 per cent. Now, does it seem worth while to sacrifice two guns (as the French have done) for 85 per cent of a battle in order to have two more for 15 per cent of the time? And have not the Argentines themselves sacrificed some 30 degrees of their arc of maximum offense in order to increase their actual fore-and-aft fire by two guns?

As for the Americans, we cannot understand why they did not go further and adopt what looks like the best plan of all. We refer to the suggestions of Lieut. De Feo of the Italian navy, for it was he who first called attention to the merits and strong points of that method of solving the question of systematization of artillery. (Cf. Revista Marittima, March, 1906.)

Altogether, we think the Russian scheme by all means the best, and the French system the least good of all the four types under consideration. On the other hand, we think the Russian disposition of the torpedo-defense guns very inferior, while the French have easily excelled in this, barring always the four guns in the stern. In the matter of protection the Argentines rank first and the Russians last; but the differences are not very vital.

From a technical point of view there is little doubt but that the Russians have succeeded most happily in combining with intelligence the elements of great gun-power, good protection, and high speed on a very modest displacement; among the rest we think the least successful have been the Americans.

But to anyone familiar with the internal workings of the United States Navy Department this will cause little surprise, nor prove difficult to explain.* And indeed the large margin of safety and general habitability inherent in these ships compensate in a way for the many apparent extravagances of their design.

In conclusion, be it said, each of the four types which we have examined presents in itself some noteworthy departures, the study of which must needs prove profitable notwithstanding the constantly changing aspect of naval construction from year to year.

---

* "Hearings on the proposed Navy (Re) organization," 1910, pp. 463, etc.

DO WE WASTE 95 PER CENT OF OUR FUEL?

IN Power and the Engineer a correspondent writes: "In reading a book which has recently appeared, I came across this statement which astounded me: 'But 5 per cent of the potential power residing in the coal actually mined is saved and used. For example, only about 5 per cent of the power of the 150,000,000 tons annually burned on the railroads of the United States, is actually used in traction. Ninety-five per cent is expended unproductively or is lost. In the best incandescent and electric-lighting plants but one-fifth of one per cent of the potential value of the coal is converted into light.' This may be true, but it seems incredible that in the conversion of potential into mechanical energy there should be such an enormous waste. What are the facts in the case?"

The correspondent's statement is true to this extent and in this way:

A British thermal unit is the amount of heat necessary to raise a pound of water 1 deg. F., and is equivalent to 778 foot-pounds of work.

A pound of good coal may contain somewhere around 14,000 B.t.u. or the equivalent of

$$14,000 \times 778 = 10,892,000$$

foot-pounds.

A horse-power is 1,980,000 foot-pounds per hour.

An engine which could produce a horse-power for an hour with the consumption of one pound of coal would therefore convert into work,

$$\frac{1,980,000}{10,892,000} = 0.18$$

or 18 per cent of the energy inherent in the fuel.

The ordinary engine takes five or six times this much.

There is a great loss in the conversion of energy, after the engine develops it, into light.

On the other hand, we are limited by our environment and conditions. We can get, with exceptional boiler work, 80 per cent of the energy of the fuel into steam, but an ideally perfect heat engine would take out of this steam only a fraction represented by

$$\frac{T-t}{T}$$

where

$T =$ Absolute initial temperature or high heat level;

$t =$ Temperature of rejection or low heat level.

Heat is convertible into mechanical energy only by working it from a higher to a lower temperature level. To get all the heat into energy the heat must be worked to the level of absolute zero. To take an hydraulic analogy, each pound of the water in a pond 1,000 feet above the sea level has in it, due to its elevated position, 1,000 foot-pounds of energy, which it will give up if allowed to fall to the sea. But if the configuration of the country is such that the greatest fall obtainable in the vicinity of the pond is 100 feet, an ideally perfect turbine could only get 100 foot-pounds out of each pound of the water, or 10 per cent of its inherent energy.

$$\frac{H-h}{H} = \frac{1,000-900}{1,000} = 0.10$$

or 10 per cent.

The absolute zero of temperature is 461 degrees below zero of the Fahrenheit scale. We live up on the plane where the temperature is around 70 deg. F., or

$$461 + 70 = 531 \text{ degrees absolute.}$$

The cooling water which is used in the condensers will average about 35 or 40 deg. in the winter and 70 or 80 deg. in the summer. Unless we use impracticable quantities of it we must let it heat up to 100 or 110 in absorbing the heat necessary to maintain the lower temperature level, which is therefore fixed at not below 100 deg. F., or 561 deg. absolute.

The temperature of 180 pounds steam is 373 deg. F.;

$$373 + 461 = \text{degrees absolute.}$$

The efficiency of an ideally perfect engine under these conditions would be,

$$\frac{T-t}{T} = \frac{834-561}{834} = 0.33$$

or 33 per cent.

Even with 100 per cent boiler and engine efficiency we could then under our conditions (and with our present knowledge) get, with an engine working between these limits, only 33 per cent out of the fuel. With 80 per cent boiler efficiency and a perfect engine we might readily get

$$0.80 \times 0.33 \times 100 = 26.4 \text{ per cent.}$$

Steam engines are built which get out 60 odd per cent of the energy due to the fall between attainable temperature limits, say,

$$26.4 \times 0.65 = 17 \text{ per cent,}$$

which comes pretty nearly to the 18 per cent which, as was shown at first, would be represented by the pound of coal per horse-power which is in sight and has been attained by some exceptional engines.

The gas engine with a wider temperature range actually attains between 25 and 30 per cent.

If a perfect engine would only realize 33 per cent, there may be some doubt of the propriety of calling the other 67 per cent a "waste." It is a waste only in the sense that the tailrace flow of a water power is a waste. In the present state of our knowledge we see no way in which it can be saved. But there is this curious fact. The animal organism is evidently a sort of a heat engine in which energy is produced by the combustion of food with a greater efficiency than we are able to obtain and with no perceptible temperature difference.

The average efficiencies of actual plants are much less than those quoted, and the 5 per cent which our correspondent mentioned is a very reasonable estimate.

ELECTRICITY IN GAS WORKS.

MODERN COAL-HANDLING INSTALLATIONS.

BY DR. ALFRED GRADENWITZ

In view of the keen competition between gas and electricity, it seems strange at first sight that there should be a possibility of co-operation between the two. Still the way for such a result has been prepared during the last decade and the electro-motor, by the useful services rendered to the gas industry, has become a link uniting these once opposite branches of industry.

As regards the manifold uses the electro-motor is put to in gas works, we wish at first to draw attention to the enormous crane plants erected, e. g., in connection with the Tegel Gas Works of the city of Berlin.

Fig. 1 represents the electrically-driven coal grab installed near the harbor of that works and which comprises two traveling double cranes on each of

Gas Works (Fig. 3). The capacity of the two bridges arranged beside one another corresponds to the full output of the grab installation represented in Fig. 1. These bridges are in turn moved on intermittently by the trolleys passing over them, thus insuring a uniform coaling of the silo; they can, moreover, be moved on by hand.

The coal taken out of ship holds by the grab cranes

FIG. 3.—STORAGE OF COAL BY MEANS OF DUMPING BRIDGES AT TEGEL GAS WORKS. THEIR CAPACITY EQUALS THE TOTAL OUTPUT OF THE GRAB INSTALLATION SHOWN IN FIG. 1.
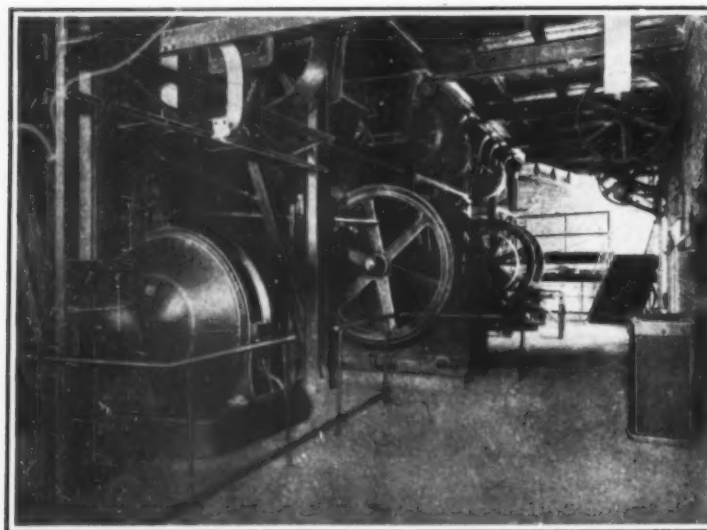

FIG. 4.—COAL-DRESSING PLANT AT TEGEL GAS WORKS COMPRISING FOUR JAW CRUSHERS EACH OF 30 TONS HOURLY CAPACITY.
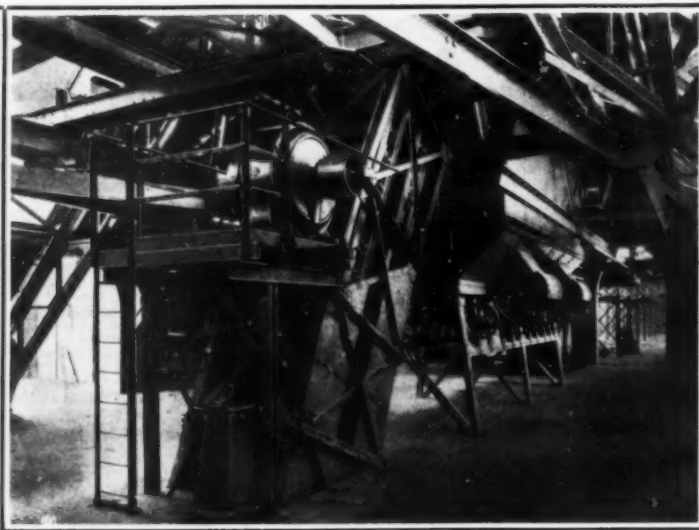

FIG. 5.—TWO ELEVATORS OF SAME PLANT FOR CRUSHED COAL OF 150 TONS HOURLY CAPACITY.

ELECTRICITY IN GAS WORKS.

When the powerful development of electricity had induced gas engineers to design their works on more modern lines and on greater scales, they found the old method of coal and coke loading by the shovel and wheel-barrow utterly insufficient, the more so as the cost of manual labor was on a steady increase. They, therefore, turned their attention to the electro-motor, which obviously was the only suitable prime mover for performing the most various operations, thus resorting to the services of an agent so far considered as unavailable.

How extensive a scope the electro-motor has acquired in gas works may be gaged from the fact that the A. E. G., which was the first continental electric company to take up this idea, during the last ten years has equipped about one hundred and fifty gas works with electric power, comprising motors of a total output of about 107,000 horse-power.

which are mounted two jib cranes free to rotate through a small angle. On each of the four jibs is traveling a crab fitted with a grab-lifting bar; on each double crane are installed twelve motors, giving a total of twenty-four, every two of which (with an output of 50 horse-power) serve jointly to operate the lifting gear. The capacity of this plant is $4 \times 40 = 160$ ton-hours.

In a similar manner the coal supply from the railway wagons is effected by wagon-tilting plants such as those of the Danziger Strasse (Berlin) Gas Works, represented in Fig. 2. This plant unloads eight wagons of ten tons, six wagons of fifteen tons, or four wagons of twenty tons each per hour, and is driven by an inclosed motor of 18 effective horse-power.

Another important point is the storage of coal by means of dumping bridges entirely automatic in working, such as those of the coal silo at the Tegel

is stored by means of the trolleys and the dumping bridges referred to in the coal silo in order then to be removed by the aid of other trolleys, which convey it to the coal-dressing plant where the coal, having been crushed to the proper size, is supplied to the retort.

Fig. 4 represents the coal-dressing plant at the basement of the Tegel Gas Works, comprising four jaw crushers, each of 30 tons hourly capacity. Two inclosed motors, of 60 horse-power each, are used to operate that part of the plant. Fig. 5 represents the first story of the same coal-dressing plant, comprising two elevators for crushed coal, of 150 tons hourly capacity. This is driven by two motors of 30 horse-power each. From the retorts, the coke is discharged in a similar manner.

Of further special interest are the charging and the discharging machines used in connection with

horizontal retorts, which, as represented in Fig. 6, can be combined into a single machine. The operation of the latter is carried out in such a way that the discharging and charging of each retort takes only two minutes; the electric equipment comprises three motors of 15 horse-power total capacity, which are used for traveling, discharging, and charging, respectively. Having been brought to the furnace, the loading and unloading machine at first throws out of the retort the heated coke, in order afterward—by the aid of a special arrangement—to throw a new charge of coal into its interior. The man operating this interesting machine has only to take care of insuring a proper horizontal and vertical adjustment.

It would be quite impossible within the limits of this article to discuss all the different uses of electromotors in modern gas works, comprising the operation of capstans, locomotives, different kinds of coke chutes, scratcher conveyers, Bradley works, elevators, door-lifting gears for chamber furnaces and coke-quenching towers, ventilating fans for withdrawing gases from the retorts or chambers, blowers for coke gas production, shaking sieves, and many other appliances. In fact, the working of an effective gas plant would be quite impossible without the co-operation of electricity.

A CURIOUS KIND OF RAILWAY CAR.

A SHOOTING CAR FOR A NATIVE CHIEF IN INDIA.

BY F. C. COLEMAN.

THE photographs reproduced herewith illustrate a novel type of railway locomotive and coach combined, constituting a shooting car, which has been built by Messrs. McEwan, Pratt & Co., Limited, of Wickford, U. S. A., for the use of His Highness the Rao of Cutch. The engines consist of a four-cylinder gasoline motor, having 4-inch by 5-inch cylinders, designed to develop about 27 brake horse-power at a speed of 900 revolutions per minute.

Three speeds in either direction are provided for, the gearing to the driving axle being such as to give speeds to the car, respectively per hour, of 10, 20, and 30 miles. There is a single pair of driving wheels, 2 feet 6 inches in diameter, placed under the center of the engine room, and the ends of the car are supported by means of four-wheeled bogies, each having wheels 1 foot 8 inches in diameter, and a wheelbase of 3 feet 6 inches, the total wheelbase of the car being 18 feet. The total length over frames is 26 feet, and over the central couplers 28 feet 10 inches. The body of the car is divided into three compartments with two end platforms for the driver for use in traveling in either direction. The central section comprises the engine room directly over the driving wheels, and an upper compartment for the carriage of game, guns, and stores. On either side of this section are two passenger compartments, richly equipped and upholstered with horsehair covered with buffalo leather. The whole exterior is finished in accordance with the best carriage practice.

This car is built for the 2-foot 6-inch gage, and is designed to carry one-third of the total weight on the driving wheels. It is constructed to negotiate curves of 300 feet radius and gradients of 1 in 50, and to attain the speeds already mentioned when carrying a load consisting of eight passengers, the driver and 4 hundredweight of luggage.

The gradient upon which the car was actually tested was 1 in 19, which was climbed at about 8 miles per hour.
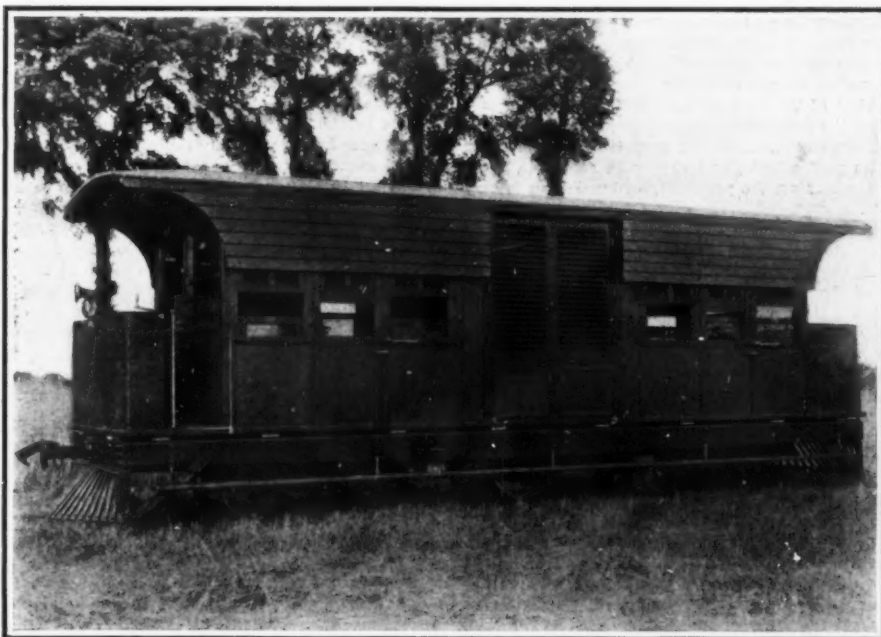
It will be noticed that the car is fitted with cow-catchers and central couplers of standard Indian pattern.

The vehicle has been built according to the designs and requirements of Messrs. E. R. Calthrop & Partners, consulting engineers, of London.

VIEW SHOWING DOORS AND SUNSHADES CLOSED.

A new method for producing high tension discharges was discussed by Prof. Ernest Wilson and W. H. Wilson, before the British Association for the Advancement of Science. According to this method, energy is taken from an alternating or continuous current source and stored in a magnetic field by an inductance; it is then permitted to surge into a condenser, which forms with the inductance a low frequency oscillatory circuit. When the energy is accumulated in the condenser the latter is mechanically bridged across the primary winding of an induction coil, with which it forms a high frequency oscillatory circuit. The energy is then transmitted by the secondary winding of the induction-coil to the work circuit, and can be of an oscillatory or uni-directional character, according to the purpose in view. The apparatus is light, efficient, and cheap, and is especially suitable for radio-telegraphy, X-ray, and other work in which high-tension electricity is employed.

END-ON VIEW OF SHOOTING CAR WITH DOORS AND SUNSHADES CLOSED.
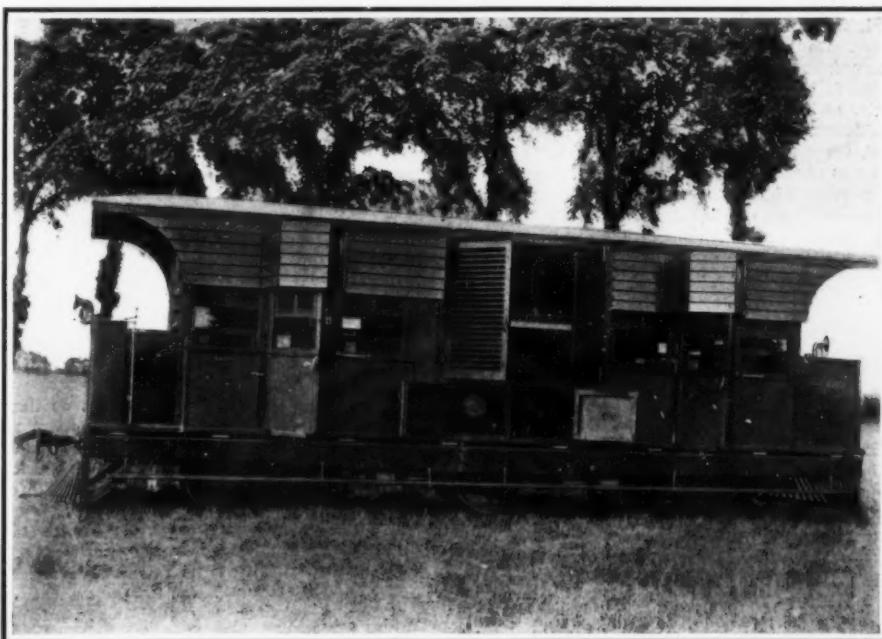
BROADSIDE VIEW OF SHOOTING CAR WITH DOORS AND SUNSHADES OPEN.

A RAILWAY SHOOTING CAR FOR INDIA.

TURBINE TROUBLES.

THE CAUSE OF SOME MISHAPS.

MARINE steam turbines of the Parsons type have now been in service for some years, so that it becomes possible to discuss the troubles to which they have shown themselves liable with some degree of fullness. Doubtless a large proportion of the earlier mishaps were such as are common to all radical departures from existing practice, until undesirable features are eliminated from the design and experience is gained in operation. However, although the design of the marine steam turbine has been considerably improved, and a long experience gained in service, it is still not altogether free from breakdowns. The great number of accidents are seldom heard of outside a limited circle, as, naturally, those involved do not advertise such occurrences; but it is very safe to say that there are few, if any, firms manufacturing steam turbines for marine work who are without some unfortunate experiences.

In view of the thousands of blades in the Parsons turbine, the fine clearances, and varying conditions of temperature, etc., it is not surprising that blading troubles predominate, and it may be said that, apart from the blading, the possibility of breakdown is very remote.

In comparison with reciprocating engines, it must be admitted that the turbine is much freer from accidents. However, with the reciprocating engine most of the working parts are visible and accessible, and the trained eye and ear can usually locate and remedy trouble before mishap occurs. In addition, there are few conceivable breakdowns with a reciprocating engine which cannot be repaired at sea.

With the turbine the circumstances are very different. The condition of the blading and dummy rings, the most vital parts, must be largely taken on trust, and a breakdown due to blading troubles is usually of such a nature as to preclude the possibility of repair at sea.

The overhauling of a set of turbines is generally a long process, necessitating the dismantling and stowing of a great many parts, the breaking of numerous joints, and often the erection of a considerable amount of gear before the turbine casing and rotors can be lifted and the state of the blading, etc., ascertained. In the majority of cases a week at least is necessary for such an overhaul, while, with the larger installations, more than twice or even three times that period would not be too long. Thus, it is not an operation which an engineer-in-charge would be anxious to undertake. With reciprocating machinery it is the usual practice to take off the cylinder covers and examine the cylinders, pistons, and valves, and also thoroughly to overhaul all the working parts at frequent intervals as a matter of routine. As explained above, the corresponding examination with the turbine system is a much more serious business, so that it is carried out at longer intervals, and the operating engineer is often entirely ignorant regarding the state of the blading, etc. The statement is sometimes made that if a turbine is not giving any trouble it is best left alone. This statement requires some modification. No doubt a turbine is best left alone so far as any interference with the dummy clearance is concerned, but an engineer-in-charge cannot see the interior of his turbines too often. In some cases an examination has revealed a state of affairs which would, sooner or later, have led to disaster, although there was no external indication of anything unusual. In the writer's opinion, everything possible should be done to facilitate overhauling, as this is a distinctly weak feature of most turbine installations. The lifting gear should be as simple and direct as possible, and every effort should be made to reduce the necessary dismantling of pipe connections, etc., to a minimum.

Let us now turn our attention to the various causes of blading troubles. A large proportion is due to the rotor or casing blade tips coming into contact with the casing or rotor, respectively, and, although it is now the usual practice to thin the tips of the blades, the effects are only modified by this means. The disappearance of the running clearance can generally be traced to some of the various causes about to be discussed, but it is indisputable that in many cases an increase in the clearances would have avoided accident. This raises the question as to whether the usual running clearances are adequate. Theoretically, of course, reduction in blade tip clearances is synonymous with an increase of economy, but in actual practice slight increases over those advised by the patentees do not seem materially to increase the steam consumption. Thus, one of the latest British scout cruisers achieved remarkably economical results, in spite of the fact that her clearances were all some five-thousandths of an inch greater than designed. On the other hand, a well-known firm obtained very good results with the turbines of a British battleship, and attributed this to their reducing the blade clearances. However, on attempting to repeat this performance with another naval vessel, the trials were brought to an abrupt conclusion by a most disastrous strip.

It is quite obvious that any attempt to secure superior economy by a reduction of blade-tip clearances is a most unwise proceeding, especially so on account of the parts affected being invisible and impossible of adjustment. It would seem that slight increases over the usual running clearances would greatly reduce blading risks at the expense of only a slight increase in steam consumption. This applies more especially to the turbines of naval vessels, in view of their widely varying conditions of service. In the majority of cases the disappearance of the clearances is due to distortion of the turbine casing. Any one who has not actually experimented would be struck by the curious distortion of some turbine casings under heat, and it is evident that in most cases the clearances measured cold are very much reduced when the turbine is hot. When the turbine casing is heavily ribbed most surprising distortions occur, and for this reason the castings should be as simple as possible. Deep circumferential bulb ribs should be avoided, and the requisite strength obtained by thickening the cylinder itself. It is usual to arrange a deep longitudinal rib along the bottom of the casing to give the necessary stiffness in this direction. It is impossible to lay down any hard and fast rules governing the distortion of turbine casings, but the writer has observed that the distortions are of much smaller magnitude when the casings are relatively short. When the casings are abnormally long, they usually develop a tendency to "hog" under heat, i. e., the center tends to rise, and in extreme cases the actual amount of this distortion may make it a matter of great difficulty to make suitable allowances. Where the stern turbine casing is incorporated with the low-pressure turbine the overhung end usually tends to rise under heat, and for this and other reasons the clearances in the astern turbine should be ample.

A very frequent cause of blading strips is local distortion of the casing produced by local temperature variations. Thus, an accident occurred to the astern turbine of a recent cross-Channel steamer on her first trip. In this case, instead of the silent blow-off pipe being led into the condenser, as is usual, it was connected to the exhaust end of the casing in way of the astern turbine, and the strip was attributed to the local distortion produced by the rush of high-pressure steam when the silent blow-off was operated. Local distortion may be the result of rapid or incomplete warming up, and in this connection it may be said that the turbine should have as long and as thorough a warming up as possible. Any undue haste in this direction is apt to entail a heavy penalty. In the larger turbine installations special warming-up connections are fitted and by this means more or less equable expansion is seen. In most smaller jobs, however, no such arrangements are made, and greater care is necessary. It is usual to give the rotors a turn or two with the turning gear to insure that the temperature is equal on all sides. Neglect of this precaution when rapid warming up is essential is apt to cause severe vibration on starting, if worse trouble does not result. On the other hand, the British Admiralty do not advise the use of the turning gear when warming up unless special arrangements are made, their reason being that if the rotor is already distorted severe damage may be done to the blading when the turning gear is operated. The best and safest practice is to make the process of warming up as long and gradual as possible.

While discussing this subject, it may be noted that strips have occurred to the cruising turbines of recent torpedo-boat destroyers. The conditions under which these turbines operate are most severe, as they are frequently called into service on very short notice. The steam connection is usually on one side of the casing, so that this side is subject to a higher temperature, and local distortion must take place unless the turbine is very carefully started up. The various steam connections which enter the turbine in way of the blading are sometimes sources of trouble. The by-pass valve, which admits full-pressure steam, has been blamed for several strips in recent naval vessels. This fitting requires very judicious manipulation, and, in the writer's opinion, would be better left off, constituting, as it does, a possible source of trouble in careless hands. The closed exhaust connections to the turbines should also be carefully handled. The branch pipes from the auxiliary exhaust main range should be taken off at the top of the range, to preclude, as far as possible, water entering with the steam. The valves on the turbines controlling these connections should be well drained before being opened, and the opening should be gradual. Attention should be given to any leak-off connections from the glands which may enter the turbines in the way of the blading, and care should be taken to clear the connecting pipes of water, and also to operate the valves in such a manner as to prevent any sudden rush of steam. There appears to be a somewhat greater tendency to produce priming with turbines than with reciprocating engines, as the turbine has a great capacity for drawing off steam. Priming is very apt to occur with a turbine installation if the stop valves on the boiler or boilers nearest the turbines are opened too wide. The writer has seen several instances of very severe priming due to this cause, more especially with the earlier turbine vessels, and one of the express Cunarders suffered in this way on her official trials. Any sudden rush of steam is very apt to bring water with it, and priming, once started, is very difficult to stop. Thus it is very necessary to avoid opening out suddenly any of the various valves controlling the steam supply to the turbines. For instance, the high-pressure turbine of one of the first turbine cross-Channel steamers was badly stripped on the first trip after leaving the contractor's hands, owing to the too sudden opening of the regulator.

When admitting steam to the astern turbine it will be evident that gradual opening out is especially advisable. On account of the small number of rows of blades in this turbine, a sudden opening out is almost equivalent to connecting the boiler to the condenser. In addition, this turbine under normal circumstances is revolving in a vacuum, so that severe distortion may reasonably be expected when it is very suddenly started up. For this reason astern turbines should have ample blade clearances. A case in point came under the writer's notice some time ago. A large turbine steamer was in mid-ocean when "full speed astern" was rung down to the engine room. The order was promptly obeyed—too promptly, as subsequent events proved. For on opening up the turbines afterward it was found that the blades in the last expansions of the low-pressure turbines were almost closed up, owing to the rush of water brought over with the steam when the astern turbine was suddenly started.

There can be very little doubt that the presence of water brought over with the steam has been responsible for several obscure cases of blade stripping, as a rush of water may very conceivably bend blades or break binding strips, and so cause disaster, and the opinion is gaining ground that the adoption of steam separators would in many cases be advisable.

When trouble arises from the mechanical construction or attachment of the blading itself, it can usually be traced to some fault in connection with the lacing or binding wire generally due to defective brazing. Segmental blading is now largely used, and while the adoption of this system no doubt facilitates blading operations, there seems to be an impression in some quarters that there is more scope for inferior workmanship with this style than with the individual method.

Whatever method is adopted, the best workmanship and most careful inspection is essential if a sound job is to result. A recent improvement to the tools for calking the packing pieces consists of a raised portion or island in the center of the tool, which insures much sounder calking with the heavier blading sections, and also leaves a distinct impression which is of considerable assistance when inspecting.

In the early days of turbine construction a large proportion of the mishaps could be directly attributed to defective design. Thus, the rotors were very crude affairs compared with the designs of to-day. The usual construction was to make the drum of boiler plate fitted with an internal butt-strap at the joint and stiffened with stays screwed through from side to side. In the larger sizes additional stiffness was secured by fitting internal rings of cast steel made in segments bolted together, the outer flange being attached to the inside of the drum by means of screwed pins riveted over. Such designs frequently gave trouble, and in more than one case the joint of the drum opened up, entirely wrecking the turbine.

Modern rotor drums are of weldless steel, and have frequently internal stiffening ribs turned out from the solid.

Other parts which gave trouble were the wheels securing the drums to the spindles or rotor shafts. They were almost invariably made of cast steel, and the arms or spokes had an unfortunate tendency to crack. This type of wheel is still frequently fitted in merchant vessels, often with the arms curved, but

the risk of fracture is always there, so that the wheels for British naval vessels are now always of forged steel, which also simplifies balancing operations. They are generally of the "arm" type, the spaces between the arms being sawn and slotted out. Wheels of the "disk" or "dished-piston" type are also sometimes fitted, but this style of wheel is generally weak in a fore-and-aft direction, and compares very unfavorably with the "arm" type in this respect, so that its use is not to be recommended. Cases have come under the writer's observation where the adoption of this style of wheel has resulted in the dummy rings being carried away. The rotors of the "Mauretania" are important examples of the very best design. In this case the wheels are of the piston type, but each wheel is made up of two pistons dished in opposite directions. These are of forged steel, screwed and shrunk upon the spindles, and bolted at their outer edges to each other and to an internal flange on the rotor

drum, making an immensely strong construction.

Apart from the blading, the possibility of trouble is remote, providing that the lubrication of the turbine bearings is efficient. Forced lubrication is usually fitted, and should give no trouble. There must, however, be no cessation of supply for no matter how short an interval, or the consequences will be disastrous. Thus, in the larger classes of British naval vessels the supply pipes to the bearings consist of two entirely independent systems. It is advisable to carry a low pressure of oil at the bearings, usually under one pound per square inch, so as to minimize leakage losses. Another point which should be noted is that the temperature of the bearings may quite safely be very much higher than is usual with reciprocating engines. It is now a common practice to fit thermometer connections to the oil wells below the turbine bearings so that the temperatures may be noted. Instead of the forced lubrication system, in

some cases the oil is pumped to sight-feed lubricators on the bearings. These lubricators have usually a valve combined with them to regulate the flow, and this, together with the advantage of actually seeing the oil entering, constitutes a considerable improvement. The adjusting blocks, which fix the fore-and-aft position of the turbine rotors, sometimes give trouble at one particular speed at which the steam balance may not be good, but careful fitting and grinding up will overcome this trouble, unless the balance is very bad, when an alteration to the dummies will be necessary.

In conclusion, it must be admitted that the Parsons turbine constitutes a great improvement on the reciprocating engine so far as freedom from running troubles is concerned, and, with ample blade clearances, good workmanship, and intelligence in handling, it would be difficult to find its superior in this respect. —The Engineer.

OCTAVE CHANUTE, 1832-1910.

A PIONEER IN AVIATION.

OCTAVE CHANUTE is dead, and one of the greatest pioneers of flight has closed a long and honored association with the world's progress. Born in Paris on February 18th, 1832, Chanute was over 78 years old when he passed away at his Chicago residence on November 24th. The greater part of his life he spent in America, and spent it to such purpose, indeed, that before he took any active part in the furtherance of aviation he had already attained to the head of his profession as civil engineer. His particular work was the construction of railways, and at different periods he was engineer-in-chief to many of the principal and now famous trunk systems of that great country. Sometimes he found himself in charge of the construction of two or more lines at the same time, as, for instance, when he was chief engineer of a section of the Kansas City, Fort Scott, and Gulf Railway, the Leavenworth, Lawrence and Galveston Railroad, a connecting line between these two belonging to the Santa Fé, and a northern section of the Atchison and Nebraska Line. Among other positions, he occupied for a period of ten years the post of chief engineer to the Erie Railway, and by his brother professional men was in due course honored with the presidency of the American Society of Civil Engineers. It is only proper to refer to these attainments, because Chanute did not associate himself actively with the progress of flight until his later years, when he had retired from the more exacting duties of his profession; and many students of aviation may possibly be unaware of what type of man it was who thus gave his unstinted support to the inception of a movement that was then not only embryonic in its infancy, but commonly regarded as having a very problematical future.

Attracted to a study of the principles underlying flight, Octave Chanute adopted in the first instance the eminently practical proceeding of passing in review the experiments of others in order to find out whereabouts he might most properly commence research on his own account and in what direction it might be most profitably pursued. These researches, originally taking the form of articles, subsequently developed into his famous work entitled "Progress in Flying Machines," which was published in New York in 1894, and has for some time been out of print. It is, without question, the most valuable work

of its kind in existence, for it consists of a very close, although very concise, study of practically every experiment in aviation made up to that time.

Octave Chanute, however, was not content with learning about the experiments of others, for he was keen on furthering progress by his own practical work, and he decided to give such time as he could to that purpose. Like Lilienthal, he grasped the importance of gliding flight, and having published an article strongly recommending others to pursue this art, he decided to institute practical experiments, if not exactly personally—for he was already 64 years of age—at any rate at his personal expense. He therefore secured the services of A. M. Herring, a much younger enthusiast than himself, who had previously made some gliding flights of his own on a Lilienthal apparatus in 1894. This machine Herring rebuilt, and also another on very different lines, suggested by Chanute. The apparatus was completed in June, 1896, and transferred to a suitable site on the shores of Lake Michigan, near St. Joseph, for trial. Chanute's glider consisted of no fewer than six pairs of wings, and experiments were conducted to find the most satisfactory disposition of the surfaces, of which five pairs of wings were ultimately superposed, while the sixth pair formed a tail. The most important new principle introduced into Chanute's glider, however, was that of maintaining equilibrium by means of moving the wings instead of the pilot. Lilienthal maintained his balance in the air by moving his body, within the frame of the machine, in any direction that might be required, and the long continued success of his experiments was unquestionably due in a large measure to his gymnastic skill and strength in performing these evolutions. Chanute, on the contrary, made the surfaces movable instead of the man, and inasmuch as his machine was designed so that the movement in question should take place automatically—that is to say, without any action of control on the part of the pilot—it is to Chanute that we must give the credit of having first definitely attempted to produce a naturally stable machine. Reasonable success attended experiments with this device, but the principal idea of Chanute and his assistants being, apparently, to try various schemes, other machines were also built and tested. One of them was a biplane trussed with struts and diagonal

wire bracing, which became, therefore, the prototype of the modern machine of this class. Chanute's experiments lasted until September of that year (1896), when the camping party broke up for the winter, and they were not afterwards renewed. Chanute was even then 64 years of age, and although attracted to such experiments with all the fervor of youth he doubtless deemed it wise to moderate his personal participation in such experience. Moreover, the trials had served their purpose so far as Chanute was concerned, and their results coming from such an authority in the engineering world induced a widespread interest in the subject.

Although ceasing experiments on his own behalf, Chanute maintained an unabated interest in the practical side of the subject, and, good sportsman that he was, he went into camp with the brothers Wright when they established themselves at Kitty Hawk in the summer of 1900. Chanute stayed with the brothers Wright for about a week, and the close association of these three minds must have been an important factor in the rapid development of the Wright machine. Indeed, it has always seemed to us that Chanute's active interest in the subject at large was of greater service to its development than his own active work, useful as that was, for he was acquainted with the researches of everyone and he knew most of the workers of his own time, between whom and whose work he helped to forge links whereby we can now see and take advantage of the uninterrupted chain of practical experience that was commenced by Lilienthal and was first coupled up to the train of modern civilization by the historic achievement of power-driven flight on the part of the brothers Wright in December, 1903.

It is not given to every one to see the fruition of their ideals as Octave Chanute saw them in the success of aviation, especially when they are already advanced in years when the art in question has scarcely begun. Chanute, however, must have seen many interesting changes in his life, for it extended over a period that covered the introduction of almost every modern convenience. That a man born in the "thirties" should end his days honored as a pioneer of flight is itself an all sufficient tribute to the caliber of his mind—to the progressive spirit of Octave Chanute.—Flight.

THE FUEL SUPPLY OF A GAS ENGINE.

An ABSTRACT of a paper, on the direct measurement of the rate of gas supply to a gas-engine by means of an orifice and U-tube, was read by Prof. W. E. Dalby, M.A., M. Inst. C.E., before the British Association for the Advancement of Science, wherein he stated that an orifice in conjunction with an anemometer was used to measure the air supply at the Ashton trials of the Committee of the Institution of Civil Engineers, and more recently Prof. Ashcroft contributed a paper to the Institution of Civil Engineers describing a method of using an orifice in conjunction with a specially-designed indicator to measure the difference of pressure on the two sides of the orifice. In the Ashton trials the air supply is inferred from the anemometer readings, and in Prof. Ashcroft's method the air supply is inferred from the difference of pressure in conjunction with the orifice, which was made about the same size as the suction-pipe of the engine, in consequence of which the difference of pressure was very small. In each case calibration was effected by driving the engine from the crank-shaft end, and then from indicator diagrams deducing the weight

of air passing through the orifice. This deduction cannot be made accurately unless the temperature can be accurately measured at one point on the indicator diagram. In neither case could this temperature be measured. The gas-engine used by the author is fitted with apparatus by means of which the temperature corresponding to the pressure and volume at an assigned crank-angle can be accurately measured with a platinum thermometer. Thus all the data are observed from which the weight of air drawn through the orifice per cycle can be computed. Indicator diagrams were taken with an optical indicator giving accurate results. Every indicator-card was calibrated for pressure in situ. The peculiarity of the method is that a relatively small orifice is used—so small, in fact, that the difference of pressure on the two sides of it is equivalent to about one foot of water under normal conditions of running. This difference of pressure can then be measured by means of a U-tube, and small variations of head are easily observed. Numerous experiments established the fact that the coefficients of the orifices tried were practically constant and equal to 0.6. The gas-supply can be meas-

ured through an orifice in the same way. Hence, the mixture of air and gas passing into the cylinder can be obtained from two readings, with suitable corrections for density, at any time during the run. The orifices, in combination with their U-tubes, become rate-measurers, the one giving the rate at which air is supplied to the engine, and the other the rate at which gas is supplied.

For more than a year a commission of the Swiss Electrotechnical Society has had under observation the use of the earth as a return conductor between St. Maurice and Lausanne, and L'Industrie Electrique, quoting from a report of the commission, states that the system has worked satisfactorily from the moment when it was put in regular service, without a single derangement. Direct current at 20,000 volts is used, on the Thury system, with a single line conductor, the second line conductor having been idle during the past fourteen months. No complaints have been made by the engineers of the Federal railways, the compensating batteries installed at certain stations having absolutely prevented interference with the signals.

A WEATHER BUREAU KITE.*

HOW IT IS CONSTRUCTED.

BY ALFRED J. HENRY.

THIS paper has been prepared primarily to answer inquiries that are made from time to time respecting the construction of Weather Bureau kites. The kites now used are essentially of the same type and construction as those known as the Hargrave-Marvin pattern, devised by Prof. C. F. Marvin and used in the Weather Bureau kite campaign at seventeen stations during 1897. The only important modifications that have been introduced since that date are in the dimensions, experience having shown that a smaller and stronger size of kite is required for high winds, while for light winds a greater spread of sustaining or lifting surface is necessary. Three sizes of kites are in use at the Mount Weather Research Observatory. They may be classed as High Wind Kites, Moderate Wind Kites, and Light Wind Kites. The details of construction for the different sizes are precisely the same. As will be understood from the description and detail drawings which follow, this form of construction has certain advantages and disadvantages. One of the chief disadvantages is its frailty. Collision with the ground or other object is almost invariably followed by a bad smash of the kite; likewise when the sails become water-logged the shrinkage of the cloth is frequently powerful enough to crush the framework of the kite. On the other hand the broken sticks are easily and quickly replaced and the kite itself is conveniently collapsed for shipment. This is a very important point at Mount Weather, since in the course of a year a large number of kites have to be returned from the surrounding country.

As is well known, the kite consists of two cells joined together by longitudinal strips of straight-grained spruce. The front cell has a middle plane in it, and in this respect it differs from the Hargrave pattern. The details which follow refer to what is known at Mount Weather as the "moderate-wind kite," for winds of 12 to 30 miles per hour (5.4 to 13.4 meters per second). Its extreme dimensions are as follows:

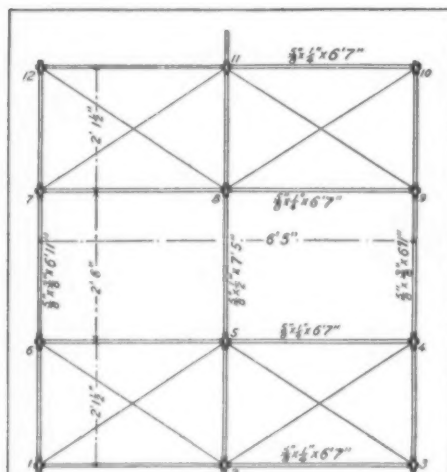|	Ft.	In.	Cm.
Length or distance fore and aft	6	8½	=205
Width or distance from side to side	6	5½	=197
Depth or distance from top to bottom of cell	2	8½	= 83

The area of sustaining or lifting surface is 68 square feet (6.3 square meters), and of steering sur-

For light winds (8 to 10 miles an hour or 3.6 to 4.5 meters per second) a kite having 120 square feet of sustaining or lifting surface is occasionally used; and for high winds (30 to 40 miles an hour or 13 to 18 meters per second) a third size is used. The latter is described in the Bulletin of the Mount Weather Observatory.[b]
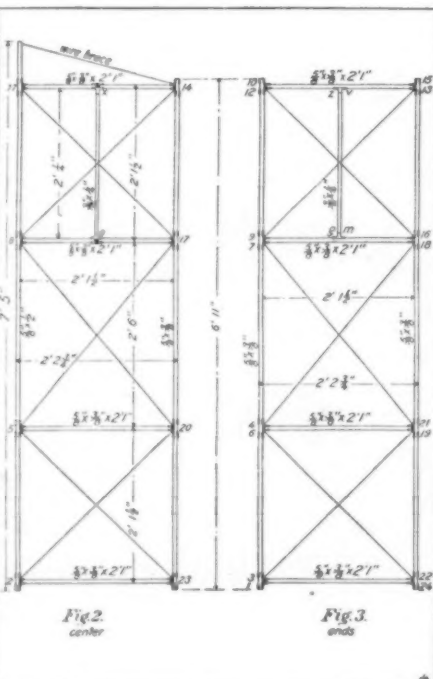

Fig. 6.
Isometric view.
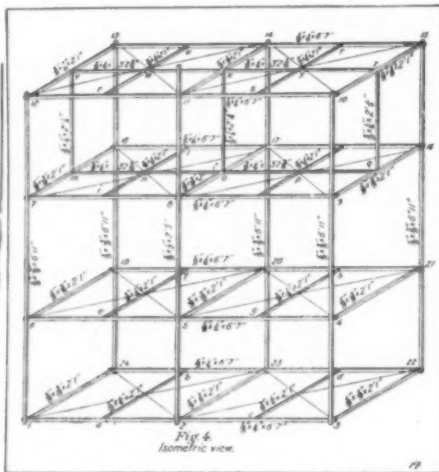
The material required in the construction of the moderate wind kite includes:

(A) Forty-one sticks of the following dimensions:

1, ⅝ inch × 1½ inch × 7 feet 5 inches
Center bridle stick; square edges.

5, ⅝ inch × ¾ inch × 6 feet 7 inches
Corners and back center; square edges.

8, ⅝ inch × ½ inch × 6 feet 7 inches
Horizontal front and back edges of cells; rounded edges.

12, ⅝ inch × ⅝ inch × 2 feet 1 inch
Horizontal sides, tapering to ⅝ inch × ¼ inch at ends.

8, ⅝ inch × ¼ inch × 2 feet 1 inch
Horizontal intermediates, bracing horizontal sides; rounded edges.

(B) The sticks are made of straight-grained spruce. All horizontal sticks should have their edges rounded, so that the end resistance of the kites to the wind will be less. Thirteen yards of Lonsdale cambric 26½ inches wide; some coarse waxed linen thread for lashing angles to sticks; 175 feet of fine piano wire, diameter 0.028 inch, for bracing.

(C) Forty-eight metal angles as shown by detail sketch, Fig. 6, are used to fasten the principal joints, 1 to 24, Fig. 4; thirty metal angles as shown by detail sketch, Fig. 7, for all intermediate joints, excepting at N, P, Y, and W, which are simply lashed with waxed thread. The isometric detail, Fig. 6, shows how these joints are fastened. These metal angles are made especially for the Weather Bureau. They are not on the market.

Fig. 1 is an elevation of the front or bridle face of the kite, i. e., the lower surface when flying. The opposite face, i. e., the upper surface or rear surface of the kite, is the same except as to the size and length of the bridle stick. Fig. 2 is a sectional elevation showing the central or bridle truss, and Fig. 3 is an elevation of one of the two side trusses. The fine diagonal lines in Figs. 1, 2, 3, and 4 show the system of wire bracing necessary to preserve the form and rigidity of the framework. This bracing is all done with very fine piano wire secured to the metal angles as shown in Fig. 6 for the vertical cross bracing; in the horizontal and the long vertical bracing the wire is looped over the small bolthead in the metal angles before the bolt is tightened up. All metal angles are lashed to the sticks with well waxed linen thread.

After the frame is put together and securely braced, care being taken that all angles are true and square, the kite is ready for the sails. These are made from white Lonsdale cambric 2 feet 2½ inches wide and 7 feet 2 inches long, being hemmed ½ inch on each edge and each end. A strong cord should be passed through this hem to lessen the danger of tearing. The sails are stretched around the kite frame and lashed to the horizontal and vertical sticks with waxed thread.

A middle sail is placed in the center of the top section extending from MV to QZ (see Fig. 4). This sail should be exactly 2 feet 1½ inches wide and 6 feet 5 inches long after being hemmed as described for the main sails, and should be lashed to the sticks in a similar manner.

The method of attaching the kite to the line wire is shown in the isometric detail, Fig. 5. A stout cord about 18 inches long is fastened to the bridle stick at point 11; to this is attached a cloth-bound elastic bridle, looped and fastened as shown. To the end of this bridle is attached another stout cord, double looped about 18 inches long, with a strong brass ring at the end. This cord extends as shown, and is fastened to the extreme front end of the bridle stick. From this point a wire brace extends back and is fastened at point 14, as seen in Fig. 2. The elastic cord used in making bridles is manufactured especially for the Weather Bureau. It consists of thin strips of rubber about one-quarter of an inch wide tightly bound in a cloth cover, in the form of a small rope about five-eighths inch in diameter. On account of the elasticity of the rubber this arrangement protects the kite and wire from sudden gusts of wind by allowing the kite to take a smaller angle, thus diminishing the pull.

The head kite, which carries the meteorograph, has its brass ring fastened directly to the line. Secondary kites are attached to the line by means of cords about 125 feet long. These cords are attached to the line in the following manner: A piece of No. 12 soft iron wire about 6 feet long is bent so that a small open ring about an inch in diameter will be formed near one end; about an inch of the wire at each end is then bent at right angles, thus: |＿ₒ＿| Wrap the soft iron wire tightly about the line and then tie the cord holding the secondary kite into the ring.

Fig. 6 is reproduced from Vol. I, part 1, Bulletin of Mount Weather Observatory, and shows the method of attaching the meteorograph to the head kite.

A SIMPLE FORM OF TAILLESS KITE.

In the Agricultural Yearbook for 1898 Prof. C. F. Marvin, of the Weather Bureau, illustrated and de-

Fig. 1.
front

Kite Sticks, Clamps &c.
1   ⅝″×1½″×7′5″   square edges.   48 Metal clamps – Fig. 6.
5   ⅝″×¾″×6′11″   "   30   "   "   7.
8   ⅝″×½″×6′7″   rounded edges.   175 ft. No. piano wire
12   ⅝″×⅝″×2′1″ tapering to ⅝″×¼″ at ends.   13 yds. Lonsdale Cambric
8   ⅝″×¼″×2′1″   rounded edges.   26½″ wide.
4   ⅝″×¼″×3 2 3/16″
3   ⅝″×¼″× 2′ ¼″

Fig. 2.
center

Fig. 3.
ends

face 22.8 square feet (2.1 square meters). It weighs about 8½ pounds (3.8 kilos).

4, ⅝ inch × ¼ inch × 3 feet 2 3/16 inches
For horizontal center; rounded edges.

3, ⅝ inch × ¼ inch × 2 feet ¼ inch
Vertical center; rounded edges.

scribed in the Agricultural Yearbook for 1898 Prof. C. F. Marvin, of the Weather Bureau, illustrated and de-

c The rear cell and sometimes both cells are covered with a black fabric known to the trade as "mercerized" silk. It has the property of shedding water to a much greater extent than cambric. For that reason kites covered with it are preferred during fog.

scribed the construction of a simple form of cellular kite. The kite now to be described is of the Marvin construction, with a few slight exceptions, which were thought to be necessary after experimenting at the Mount Weather kite station during the summer of 1909.

Fig. 8 shows such a simple form of kite complete, and Figs. 9, 10, and 11 show the details of the several parts. The sticks are made of straight grained spruce, but white pine will answer as well. Either Lonsdale cambric or calico may be used for the covering. Small tacks and coarse waxed linen thread are required. The sticks should be cut to the shape and dimensions shown in Figs. 9, 10, and 11 in detail.

The kite is constructed upon a central truss, which is shown in Fig. 9. The longitudinal sticks, a and c, Fig. 8, are $\frac{1}{4}$ inch $\times$ $\frac{5}{8}$ inch $\times$ 40 inches. At $5\frac{3}{8}$ inches from each end a slight notch, which should not exceed 1/16 inch in depth, as shown at n, Fig. 9, is formed to receive the uprights. The uprights which are cut as shown in Fig. 9 must have their ends perfectly square and true. They must be seated squarely in the notches of the long spines and be firmly lashed in place with coarse waxed linen thread.

Fig. 10 shows the form to which the corner longitudinal spines A, B, C, D (Fig. 8) should be dressed; the long straight edges are to be slightly rounded as shown in section. Notice that the distances of the notches from the opposite ends are not the same.

The covering for the kite is made of two long strips of cloth. Both edges of the strips should be hemmed even if the edge has selvage, and when so hemmed the width should be just 12 inches. The total length of the strip, when stretched as it will be on the kite, should be $96\frac{1}{2}$ inches, the half inch being allowed for the lap of the cloth in sewing the ends together. The opposite end of each cloth strip should be carefully and evenly overlapped for half an inch and strongly sewed together with a double seam, thus forming two endless bands.

The next step is to mark the cloth bands at the places that are to be fastened to the frame. Stretch each cloth band out smooth and straight over two thin sticks run through inside the band. It is well to make the seam in the band come over near the edge of one of the sticks. When the band is smooth and evenly stretched, draw a pencil line across the band exactly in the middle, where it turns around the edge of each stick.
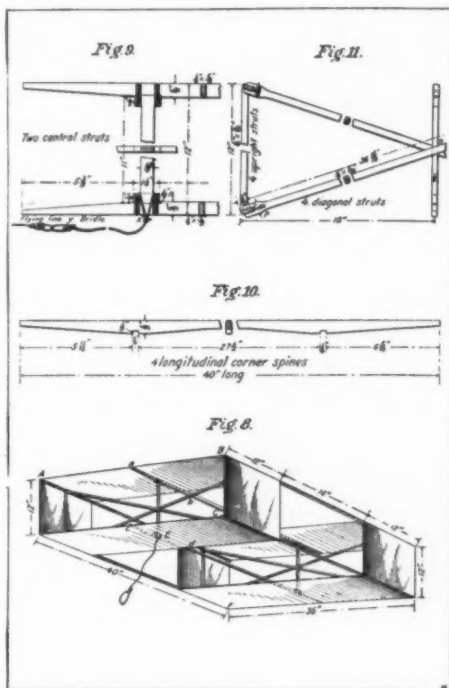
The cloth bands are now ready to be tacked to the frames of the kite. Put one of the bands over the central truss and tack from a to b, Fig. 8, with a few small 2-ounce tacks along the top sticks of the truss. The lower side must be tacked in a similar manner to the opposite truss, from c to d, Fig. 8, care being taken that the truss is exactly in the center of the cloth band. The other band is tacked in a similar manner to the other end of the kite frame. Finally, the four corner longitudinal spines are passed within the bands, taking special care that the notches in the spines will stand in their proper relation. Referring to Fig. 10, it will be recalled that the small notch at one end of each spine is nearer its end than the opposite notch is to its end. This is done in order that the diagonal struts shall pass on each side of the uprights of the central truss as shown at o, Fig. 11. In other words, see that the short ends of the spines are in the A and C corners and the long ends in the B and D corners, Fig. 8.

It is difficult to determine the exact length of the diagonal struts because the amount that the cloth bands will stretch is uncertain. The length indicated in Fig. 11 is about right if all the other dimensions are adhered to. In order to be sure that the diagonal struts fit in the proper manner it will be found better to make up a pair of struts about half an inch too long at first, then by trying them in the kite and cutting out the notches deeper and deeper a perfectly satisfactory fit can be secured, and the cloth braced out smooth and taut. Care must be taken to keep all diagonal struts of the same length. This fitting had better be done before reducing the cross section of the spines between the forked ends. The forked ends when finished should have about the dimensions shown in Fig. 11 at P. In order to prevent the forks from splitting off it is quite necessary to lash the ends just back of the notch with a serving of good waxed thread. Instead of cutting these struts out of a solid piece, as assumed above, some may prefer to build up the forked enlargements at the ends by gluing on small cleats, finally lashing on the waxed thread over all as before. In order to prevent the sides of the kite from pressing in, four upright struts are provided, the ends of which are tacked to the corner spines close to the diagonal struts, as shown in Fig. 11. After the cloth has been stretched smoothly and evenly over the frame, it should be lashed securely to the corner spines and the central truss with stout twine, sewing through the cloth and around the sticks.

To bridle the kite cut off about 6 feet of stout cord and tie one end to the central truss as shown

at E, Fig. 8, the cord passing through small holes pierced in the cloth covering. The knot employed at this point is shown at X, Fig. 9. The flying line should be tied to the free end of this cord by means of bowline knots as shown at Y. This knot is strong, never slips, and can be easily untied, no matter how much the line may have been strained.

To be perfectly safe the flying line of this kite

Fig. 9.
Two central struts

Fig. 11.
4 diagonal struts

Fig. 10.
4 longitudinal corner spines
40" long

Fig. 8.

should have a tensile strength of from 50 to 60 pounds, and be equally strong throughout. If the wind is favorable for flying, the best way to start the flight is to run out 150 feet or more of the twine while the kite is held by an assistant. When all is ready the assistant should toss the kite upward a little in the direction in which it is to go. It will then take care of itself. It is important that the kite be cast off directly in line with the wind, otherwise it may dart badly. When fairly up the kite may sweep a little from side to side, but if it ever darts or turns over there is something radically wrong, probably an uneven distribution of the cloth surface, or some distortion of the framework.

IMMENSE VALUE OF SWAMP LANDS.

CERTAIN of our Southern States, notably Louisiana, embrace within their boundaries areas which, in their present condition, are yielding their people no

greater benefit than would a corresponding area on the high seas.

It is said that such lands in Louisiana, aggregating more than 7,000,000 acres, form an area of fertility excelled by no other in the world, except, perhaps, that of the Amazon flood plain.

That portion of the alluvial district south of the Red River which is said to support the densest agri-

cultural population in the United States—three hundred and thirty persons to the square mile of cultivated land—omits entirely the urban population of New Orleans.

When it is considered what the alluvial lands now yield, it is readily perceived that the undrained lands of Louisiana, which are to-day wholly unoccupied, must be capable of supporting a great number of people. Indeed, it has been estimated that, aside from the cities which would exist there, these lands could support a population of over 3,500,000, a population that would exceed any one of forty States of the American Union. Were such lands cultivated as the sugar district of Louisiana now is, their annual wealth production would approach the value of the present cotton crop of the United States and would exceed by millions of dollars the value of our entire wheat crop.
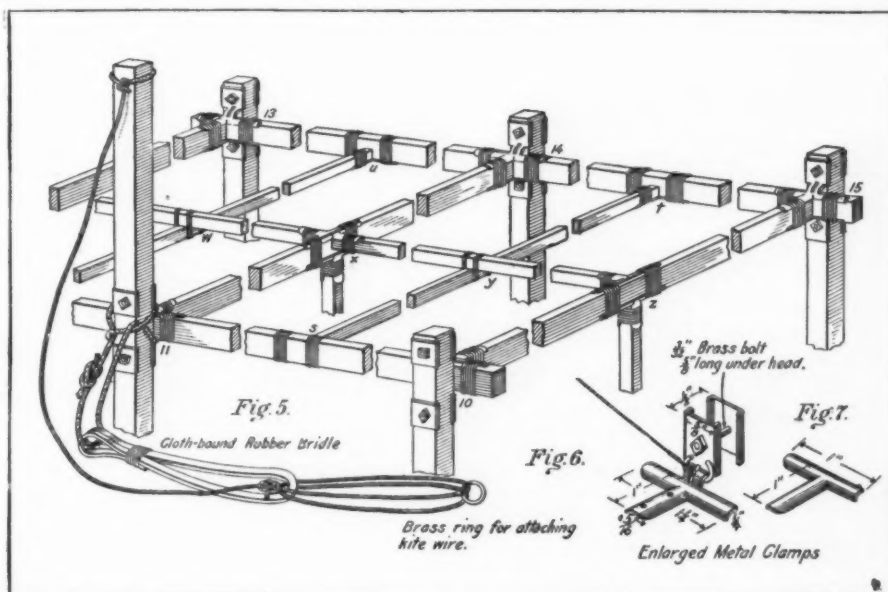
In this connection it is interesting to consider the question of alluvial areas abroad. Holland, on an alluvial area of 2,750,000 acres, which is considerably less than one-half of the undrained area of Louisiana, and with a fertility not to be compared to the Louisiana standard, takes care of some 5,000,000 persons. And Holland is almost a synonym for wealth.

Egypt has a cultivated alluvial area of 5,340,000 acres, much less than the one under discussion. Egypt supports 10,000,000 people, not up to the European or the American standard, but since the population supported to the square mile is about the same as in Holland, the lower standard of living must be ascribed to the less enterprising character of the inhabitants. Now, on 1,500,000 acres of land, Egypt produces fully one-seventh as much cotton as does the United States. In other words, one acre of cotton in Egypt is to-day worth approximately four acres in this country, and we are buying every year an increasing proportion of Egyptian cotton.

Egyptian cotton is a more valuable cotton than our standard cotton, but it is worth less than our Sea Island cotton. It happens that Sea Island cotton grows to perfection on the sea coast lands of Louisiana, and there are found in that State enough first-class Sea Island cotton lands, when once drained, to duplicate in pounds and to exceed in value all of the long staple cotton produced in the world, Egyptian included.

It follows, therefore, that the drainage of the remaining marshes and swamps in the United States is the most important natural development awaiting solution. Scores of drainage projects are now actively under way, and thousands of acres have already been brought under cultivation with most satisfactory results. When this question shall have been duly disposed of, south Louisiana will become the richest agricultural community of its size in the world.

In an address before the British Association for the Advancement of Science, Mr. Henry J. S. Sand, Ph.D., D.Sc., announced that some cathode-ray tubes are made in which a vacuum-tight seal between iron and glass has been obtained as follows: An iron wire is sealed into a glass tube. While the glass is

Fig. 5.
Cloth-bound Rubber bridle
Brass ring for attaching kite wire.
$\frac{3}{4}$" Brass bolt $\frac{1}{8}$" long under head.
Fig. 6.
Fig. 7.
Enlarged Metal Clamps

hot a small piece of heated steel tube surrounding the wire is pushed a few millimeters into the glass. After cooling, the tube is soldered to the wire. The vacuum-tight seal is produced between the inner surface of the elastic steel tube, which on cooling is put under tension, and the glass which comes under compression. Seals with wires of a millimeter diameter have been produced in this way.

ENGINEERING NOTES.

The question whether constructions of armored concrete are liable to injury from lightning cannot yet be decided from statistics, but indirect evidence on both sides is furnished by the following facts: It has recently been observed that iron completely imbedded in concrete is not entirely protected against stray currents of electricity, which destroy the normal adhesion between the iron and the concrete upon which the strength of the construction essentially depends, and also oxidize the iron. In order to protect armored concrete from these influences it must be made waterproof by a coat of tar or asphalt. If the iron forms a continuous network connected with the ground it may possibly constitute an efficient lightning protector, on the principle of Faraday's cage. Electrical fluxes would be set up in such a metallic network by the electric oscillations of high frequency which constitute a flash of lightning, even if the enveloping concrete were a perfect insulator, but whether these fluxes would be a safeguard or a source of danger remains to be decided.

The new Paris subway line, known as the North-South underground road, is now opened for regular service. Although it resembles the already-existing Metropolitan subway in its main features, it presents many points of difference from the latter, especially in the minor details. Where the line crosses the Seine we have the first use of an iron tube tunnel for this kind of work in France. Each track runs in a single tube under the river, and we already had occasion to describe this work in detail. For the rest of the subway, a double track tunnel is used, this resembling the standard tunnel which was adopted for the Metropolitan subway. The new line is already carrying a good traffic, and when in full operation there is no doubt that it will be well patronized, seeing that it connects the southern outlying districts and the Montparnasse railroad depot with the middle of the town and the St. Lazare depot. This latter is one of the principal crossing points of the new line with the Metropolitan subway. Preceding the station proper there has been constructed a handsome circular underground waiting room with ticket offices and news stands, surrounded by brilliantly lighted display windows. Passages lead from here to the railroad depot and the various sections of the subway. The North-South line is operated on a distinct financial basis from the other subway, being controlled by another company. According to the contract which was made with the city, however, transfers are made at the four different crossing points of the new line and the other subway without extra charge.

In the Zeitschrift des Vereines Deutsch. Ing. appears an article by J. Hybl on the effect of superheating and of vacuum on steam consumption. Starting with Mollier's steam tables, the author discusses, with the aid of numerous diagrams, the effect of various degrees of superheating and of higher vacua on the steam consumption of engines with and without condensers attached. It is shown that for non-condensing engines the steam consumption for increased admission pressure increases rapidly. With a higher degree of superheating the percentage steam consumption falls quicker for low pressures than for high. The superheating of the steam consequently effects a greater percentage saving for low admission pressures than for high. The curve for the percentage reduction of the steam consumption exhibits a turning-point, so that quite small and very great superheating give a smaller percentage reduction than a moderate amount; for ordinary pressures of from 10 to 14 atmospheres the percentage reduction is about the same. With condensing engines the curves are much the same, though the saving through superheating is somewhat smaller than with engines of the non-condensing type. The diagram shows that the reduction effected through superheating is so great that great efficiency cannot be secured without it. As regards the effect of a high vacuum in the condenser, this does not play an important part in steam engines, but for steam turbines the reduction of the steam consumption through using as high a vacuum as possible is about the same as for superheating. Principally on this account the steam turbine for equal pressure and superheating has a smaller steam consumption than the corresponding steam engine. It is shown that for low-admission pressures and higher vacuum a greater percentage reduction of steam consumption is effected than for high pressures. The higher the vacuum the greater is the percentage reduction corresponding to 1 per cent increase of the vacuum. For the usual pressures of from 10 to 14 atmospheres the saving effected by using high vacua is almost the same. The diagram also shows that a somewhat smaller reduction of consumption is effected by using a higher vacuum in the case of superheated steam than for saturated steam. In any case, the employment of as high a vacuum as possible is necessary for high efficiency.

SCIENCE NOTES.

M. Gauckler, the well-known French archæologist, has been continuing his excavations on the Janiculum at Rome, on the site of an ancient temple devoted to the Syrian cult. He finds that the most ancient edifice is covered by two successive structures erected at later epochs. The old edifice is a *temenos* resembling the temple of the same kind at Hieropolis, being an open structure. He found the remains of a fish pond which contained the sacred fish, and it was still kept in the second structure, only disappearing when the edifice was destroyed by Constance II. During the Christian period the site contained a public garden surrounded by colonnades. Later on, the Emperor Julian returned the edifice to the Syrian cult, and a new temple was constructed. During the excavations there were found a bust of Antonius and a statue of Bacchus, as well as a tablet bearing a dedication to the female divinity Febris.

An article on iron soaps appears in the Arch. Pharm., by K. Feist and W. Auerhammer. Attempts have been made to form with liquid fatty acids an iron salt (soap) which is stable in a solution of cod-liver oil. A ferric stearate was prepared by adding a solution of ferric chloride to stearic acid dissolved in sodium hydroxide solution, the precipitate being filtered off and washed. The salt contains 7.65 per cent of iron, dissolves in fatty oils and chloroform on warming, but separates on cooling. It melts at 103 deg. C. Ferric oelate was prepared in a similar manner from pure oleic acid, but the salt was obtained by extraction with ether instead of by precipitation. It has the composition, $Fe(C_{17}H_{33}COO)_3$, and is soluble in fatty oils, ether, and chloroform in the cold. Commercial oleic acid is unsuitable on account of its taste. Satisfactory iron soaps can be made by first preparing a potassium soap from linseed, sesamé, or almond oil, and then treating this with ferric chloride solution. A formula is given for the preparation of a cod-liver oil containing 1 per cent of iron as a soap.

P. Klemm, in the Wochenbl. Papierfab., records a case of the destruction of the dyestuff in a colored poster paper by the printers' ink with which it was printed. The printed lettering was visible from the back of the poster in the form of white characters on the colored ground, where the dyestuff in the body of the paper had been bleached. The phenomenon is attributed to the intense oxidation which takes place during the "drying" of the oily medium of the ink, which, as is known, may in special cases lead to spontaneous ignition. The oil and resin absorb oxygen most powerfully from whatever bodies may be in contact with them, and if the dyestuff be one which readily parts with oxygen giving a leuco-derivative stable in presence of air, the fading of the color is a natural consequence. A number of dyestuffs correspond with this condition, for instance, Victoria blue, and Klemm has proved experimentally with paper colored with this dyestuff, that printers' varnish may ultimately bring about the complete destruction of the color.

TRADE NOTES AND FORMULÆ.

Waterproof Packing Paper.—a. Hard soap, 750 parts; water, 1,000 parts. b. India rubber, 125 parts; glue, 375 parts; water, 1,000 parts. Both fluids are prepared under the influence of heat and mixed, the paper is immersed in the warm fluid, pressed out and dried.

Waterproofing for Sails, Ropes and Fabrics.—A solution of 20 parts petroleum, 0.25 part oil, 0.25 part rosin, and 0.12 part paraffine, effected at 165 deg. F. (75 deg. C.) is sufficiently warmed with 68 to 80 parts water, then the water expelled, rinsed again with water and dried.

Cure for Warts.—Altschul recommends as a remedy for this very obstinate trouble, the ointment described by Unna, made of gray mercury salve, with the addition of 5 to 10 per cent of arsenic. The salve should be smeared on lint and made fast to the wart by bandages. Finally painting with tar may be resorted to. The remedy is very poisonous.

Coating for Blackboards.—Dissolve 200 parts of copal in 400 parts of ether; also 1,000 parts shellac and 500 parts of sandarac in 4,000 parts of alcohol (90 per cent). Mix both solutions and add 150 parts lamp black, 50 parts ultramarine, 30 parts Venice turpentine and 1,000 parts fine Naxos emery. A coating is applied, set on fire and extinguished; then a second coating applied, allowed to dry in, rubbed down and washed off with cold water.

Belgian Axle Grease.—Lime slaked to powder, 100 parts; oil of tar, 300 parts; paraffine oil, 800 parts; rosin oil, 300 parts; strong lye, 12 parts. The powder of the slaked lime and the lye are placed in a kettle, the rosin oil added and stirred until the whole mass becomes white. This is moderately heated, the oil of tar added, stirring continuously, then the paraffine oil, and finally add 800 parts of soapstone powder. The complete composition is to be stirred until it is completely uniform in consistency.

Softening Hard Water.—On a small scale, for household use, hard water can often be softened by simple boiling. It becomes somewhat turbid thereby on account of the separation of the carbonates of calcium and magnesium, soluble only in water containing carbonic acid, when the carbonic acid is expelled. By the addition of a little soda, varying according to the hardness of the water, it can also be softened. On a large scale, hard water may be softened by the addition of a suitable quantity of lime milk. The lime combines with the free carbonic acid and thereby the calcium and magnesium carbonates, previously held in solution, are also rendered insoluble.

Transparent Water-glass Mass (Kücken).—Thickly fluid water glass (silicate) is applied to a smooth or corrugated, permanent or temporary base. As long as the coating remains fluid various objects are introduced, for instance, insects, minerals, corals, flowers, grasses, etc., and water-glass applied gradually in separate coats, until the substances are covered. (Drying of the several coatings is not necessary.) The finished and dry water-glass body, either protected by a covering of glass pressed on with water-glass as adhesive, or partly covered with glass, partly colored with colors mixed in water-glass and then protected from moisture, by a thin cement coating and varnishing.

TABLE OF CONTENTS.